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CIVIL LAND REMOTE SENSING SYSTEM

REPORT

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SUBCOMMITTEE ON
SPACE SCIENCE AND APPLICATIONS

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LETTER OF SUBMITTAL

U.S. HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE AND TECHNOLOGY,
SUBCOMMITTEE ON SPACE SCIENCE AND APPLICATIONS,
Washington, D.C., December 1981.

Hon. DON FUQUA,
Chairman, Committee on Science and Technology.

DEAR MR. CHAIRMAN: The House Subcommittee on Space Science and Applications, in conjunction with the Senate Subcommittee on Science, Technology and Space, held 2 days of hearings in July 1981 to address issues pertaining to Civil Land Remote Sensing. The hearings provided a forum for users, Government, and industry to express their views on establishing an operational Land Remote Sensing System.

The key issues that were addressed by witnesses during the hearings were: The role of the Federal Government vis-a-vis the private sector; how can Government best serve the national needs in both the public and private sectors; what should be the Government's role in R&D in the future; what regulations and terms should Government mandate, and is legislation needed for Government/industry joint ventures.

This document reflects the continuing interest and concern of the Committee for the development of Civil Land Remote Sensing. Many have contributed to the development of this report; Mr. Thomas D. Potts, Sea Grant Fellow on the Committee staff, played a key role in its development. The witnesses have done much to better define the needs and issues associated with Civil Remote Sensing from Space.

This report summarizes current remote sensing research and development activities; current planning for an operational system; international remote sensing activities; summarizes the testimony presented at the hearings; develops a number of significant issues; and offers findings and recommendations.

Sincerely,

RONNIE FLIPPO,
*Chairman, Subcommittee on Space Science
and Applications.*

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FINDINGS AND RECOMMENDATIONS

FINDING NO. 1

The United States has a preeminent position in remote sensing technology for monitoring and detecting earth resources and environmental quality which is a source of international responsibility as well as national pride.

FINDING NO. 2

As the innovator of global remote sensing technology the United States has an opportunity and an obligation to exploit this capability to promote more harmonious international relations and Third World development.

FINDING NO. 3

France, Japan, India, and the European Space Agency are each involved in the development of space borne remote sensing systems with launches planned in the 1980's. Therefore, in the mid-1980's, the United States will no longer be the sole source of satellite remotely sensed data.

Recommendation: The United States should develop a foreign policy initiative to exploit our remote sensing capability to promote more harmonious international relations and Third World development. The National Aeronautics and Space Administration in coordination with the State Department should develop a long range plan that would optimize global capability to utilize satellite remote sensing data for consideration at the upcoming United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE-82).

FINDING NO. 4

The multi spectral scanner (MSS) instrument which has been carried on Landsats 1, 2, and 3 has been adequately demonstrated for deployment on an operational space system.

FINDING NO. 5

Landsat D is expected to demonstrate the technology for an operational land observing system. However additional spacecraft will be required to provide assurance of timely and uninterrupted service.

FINDING NO. 6

Elimination of funding for follow-on space hardware due to budget constraints has again threatened long-term data continuity, a major inhibition to market development.

FINDING NO. 7

Under current administration plans the United States earth remote sensing program will terminate when the last of two Landsat D satellites fail unless by then the private sector has taken over the program.

FINDING NO. 8

To date the most serious concept advanced by the private sector involves merging the weather satellites and land remote sensing satellites into a single system operated by a designated private sector entity.

Recommendation: The National Oceanic and Atmospheric Administration should carefully assess the feasibility of private sector operation of both the weather satellites and land remote sensing satellites and report findings to the Congress by August 31, 1982. Any selection of a designated private sector entity should be accomplished through a competitive process.

FINDING NO. 9

The management and technical requirements of an operational system can be met by a number of private organizations. One of the major unknowns confronting commercialization is the lack of market definition. Although the Government may represent 50 percent of the market, neither the actual size of the Government market, nor the technical requisites for compliance of Government needs have been defined.

Recommendation: A set of federally funded, competitive, detailed definition studies should be contracted to industry by the National Oceanic and Atmospheric Administration to define the technical, market, investment and operational aspects of a system that would meet government and private sector needs. The primary objective of each study would be to provide a realistic basis for the determination of optimum government and industry roles and a development schedule for an operational civil land remote sensing system.

FINDING NO. 10

Private sector ownership of a civil land remote sensing system would likely involve exclusive rights to the Government market and protection from competition for a period after selection. The value added segment of the market should be open to encourage new users, industries and market expansion. Copyright provisions will be necessary to protect both the operator and the additive value industry.

FINDING NO. 11

The current policy of non-discriminatory access to data creates a favorable climate for national and international data exchange.

Recommendation: The United States should continue the policy of open access to civil remote sensing data and continue to encourage international exchange and assistance.

FINDING NO. 12

Many of the operational guidelines for a private sector operator could be written into a contractual agreement. The framework should include: (1) protection from competition for a period after selection, (2) compliance with U.S. foreign policy and security requirements, (3) minimum performance standard for raw data, (4) nondiscriminatory access to data, (5) assurance of fair pricing policies and (6) a performance review process.

FINDING NO. 13

Since the Federal Government may represent approximately half of the initial market base of any private operation, significant influence on pricing policy by Government and promulgation of regulations or specifications will be inevitable.

FINDING NO. 14

Government should continue high risk research and development on next generation components and systems after the commercialization of current generation remote sensing technology occurs.

FINDING NO. 15

Government/industry joint ventures represent an institutional mechanism which should receive further consideration for the transition of financial responsibility for land observing systems from the Government to the private sector.

FINDING NO. 16

Government should recover a larger share of Landsat costs, but this should be done in steps and with caution to encourage market expansion and growth of users. Research and development costs should be considered as sunk costs and should not be amortized.

FINDING NO. 17

State and federal agencies make extensive use of Landsat data for resource inventories, monitoring and planning. Fifteen states have routine operational capabilities to use Landsat data; state use of Landsat data has grown 61 percent since 1978. States are more concerned that data be continuously provided at a fair price than with who operates the system.

Recommendation: Long-lead data pricing schedules should be provided to enable state governments to adjust their legislative budgets in order to alleviate adverse impacts on state programs.

FINDING NO. 18

Universities continue to be a major contributor in remote sensing research and training activities which are important in expanding the use of this complex technology. University research and training will be inhibited by significant cost increases for data.

FINDING NO. 19

In a historical perspective the premier policy decisions that have had a positive effect on the development of civil land remote sensing technology have been: (1) long-range development of research and development beginning in the early 1970's, and (2) non-discriminatory international dissemination of data.

FINDING NO. 20

The greatest negative influence on the evolution of an operational civil land remote sensing system has been the inability to fully evaluate the relationship between Landsat and national needs and to provide a long-range policy that is continuously reflected in the budget.

CHAPTER I.—INTRODUCTION

Though man's need for food, minerals, and shelter is increasing in geometrical proportions, global resources such as water, minerals, and arable land are finite and being rapidly depleted. This increasing demand in conjunction with a diminishing supply requires current and accurate information for global resource monitoring. Resource requirements, whether for strategic minerals or food, necessitate transactions that greatly affect both local and international communities in a highly interactive process.

Resource observation via satellite is the only technology that is capable of providing global resource data on a timely, repetitive basis, making possible the detection of resources and resource change. The value of remote sensing of earth resources has been proven experimentally, and is being further developed for operational uses in geology, oceanography, meteorology, urban planning, crop prediction and a host of other areas. In addition, there currently exists an operational system of meteorological satellites which provide storm warnings and global data for use in numerical weather prediction throughout the world.

The United States currently has a highly advanced federal experimental remote sensing system for resource analysis known as Landsat. The current Landsat program represents a billion-dollar technological investment which began with the launch of Landsat 1 on July 23, 1972. Since the initial satellite, Landsat 2 and 3 have been launched to provide continued development. The Landsat D, a new satellite with an advanced sensor, is to be launched in 1982.

Based on the experience with Landsat, it would seem that operational remote sensing of earth resources is technologically quite feasible. However, in the late 1970's after several years of experimentation and three Landsat spacecraft, the United States had no comprehensive long-range plan or policy which would lead to a decision on whether or not to establish an operational system. Questions relating to an operational earth remote sensing system were debated in the Congress and the Administration throughout the late 1970's. Though a plan for the establishment of an operational system was issued by the White House in November 1979, the Reagan Administration's interpretation and implementation of this plan are still evolving.

Through the 1970's, congressional efforts have reflected a concern that the uncertainty of continuous data availability prevented a more extensive use of Landsat by many current and potential users.

A national commitment to go operational would have, according to its proponents, provided the user community with the assurance it needs. There is no guarantee on the period of the experimental phase, thereby leaving the users in a continuous state of uncertainty regarding the future.

Issues before the Congress have centered on the appropriate institutional arrangement for the Landsat system, the role of the Federal Government, and the best means of encouraging increased participation by the private sector.

With the magnitude of the investment in data interpretation equipment and personnel training, the uncertainty of the commercial market, the non-aggregate status of the user community, and the fear of lack of support from the Federal Government, the private sector has been reluctant to establish its own operational system.

Hearings on an operational land remote sensing system were first conducted by the House Subcommittee on Space Science and Applications in 1979. Administration witnesses including the Office of Science and Technology Policy (OSTP) testified that such a system was premature and that the concept needed further study before implementation. Shortly thereafter, the Administration established a Space Policy Review Committee, which included participation by all interested Federal agencies, to study U.S. space policy, including the question of whether or not there should be an operational earth resources satellite program. The study concluded that further study of an operational Earth resource satellite system was necessary. The Administration stated its intent to establish an "interagency task force to study expected technical, programmatic, private sector, and institutional arrangements for remote sensing" and to examine "options for integrating current and future systems into a national system."

Also during the 95th Congress the House Committee on Science and Technology published its second report, "Earth Resource Information Systems." This report was influential in the formulation of the Carter Administration's civil remote sensing policy. Report findings that were adopted by that Administration in later years included: (1) a goal of an orderly transition to an operational system, (2) assured continuity, (3) designation of a lead agency, and (4) foreign assistance and non-discriminatory access to data.

Additional hearings were conducted by the Subcommittee on Space Science and Applications in the 96th Congress. Administration witnesses continued to state that they recognized the importance of continuity of data, that Landsat D and its backup satellite Landsat D Prime provided sufficient data continuity through 1985, and that the establishment of an operational system was, at the time, "premature." It was the Administration position that although much experience had been gained, the configuration of future remote sensing systems still needed further comparative study before an institutional framework and desired technology mix could be selected.

In November 1979, the Carter Administration announced its decision to assign the Department of Commerce's National Oceanic and Atmospheric Administration (NOAA) the responsibility for an operational civil remote sensing spacecraft system which will include the management of all U.S. land, sea, and weather applications satellites and associated ground systems.

NOAA, in its "Issues and Options Report", planned for Federal provision of satellite data through the 1980's. The Carter Administration's 1982 budget included \$123.8 million for NOAA's initiation of the program in order to assure program continuity.

The Reagan Administration reduced FY 1982 funding for NOAA's Landsat activities and eliminated funding for any satellites additional to Landsat D and D Prime therefore leaving data continuity through the 1980's questionable. The view of the administration is that the private sector should become the owner/operator of resource observation via satellite as soon as possible. However, the Subcommittee believes that for this to occur a series of issues and questions must be addressed in several areas including: Government/industry roles, National needs, transition policy and institutional mechanisms.

With these questions and issue areas in mind, the House Subcommittee on Space Science and Applications and Senate Subcommittee on Science, Technology and Space jointly conducted hearings on Civil Land Remote Sensing Systems in July 1981.

CHAPTER II.— SUMMARY OF CURRENT LANDSAT R. & D. PROGRAM

To provide an appropriate perspective, NASA provided the following summary of the present Landsat research and development program:

Three Landsat Satellites have been launched to date. Two of them (Landsat-2 and -3) are still operating and returning useful data on a worldwide basis. Landsat-1 was retired in early 1978 after six years of successful operation.

The data from Landsat-2 and -3 are collected at three U.S. ground stations located in Goldstone, Calif.; Fairbanks, Alaska; and Greenbelt, Maryland. On Landsat-3, foreign data for U.S. needs are collected and stored by an onboard tape recorder for later playback to U.S. ground stations. The Landsat-2 onboard recorders are no longer operative, and U.S. needs for foreign data are being supplemented by direct readout to four selected foreign stations. The raw data are then shipped to the United States for processing and distribution.

Interest in Landsat data is worldwide. Through bilateral agreements, data are being received in ground stations located in Canada, Brazil, Argentina, Japan, India, Italy, Australia, Sweden and South Africa. Additional stations are planned for Indonesia, Thailand, and China. These foreign countries pay the United States a yearly fee for access to the data. The present fee arrangement is under review in consonance with the Administration's desire to recoup Landsat operating costs by data sales and foreign access fees.

All data for U.S. consumption are sent to the Goddard Space Flight Center for pre-processing. After pre-processing, the data are transmitted electronically to the EROS Data Center (EDC) in Sioux Falls, South Dakota, for final processing. The resultant data are then available to users through EDC as photographic imagery or digital data tapes.

Over 80 user organizations have developed or purchased the necessary equipment to process Landsat data into final products. These include Federal agencies, private industries, state governments, and foreign countries. The U.S. Government is presently the largest and most diversified user community with prime applications in crop forecasting, water resources management, land cover inventory, forestry, and rangeland management. Private industry applications are rapidly expanding and include uses in mineral and petroleum exploration, forest land management, agribusiness and power utility planning. In the area of state government applications, the National Conference of State Legislatures and

the Council of State Planning Agencies reported in 1981 that 15 states have established independent capabilities for continued use of Landsat data with similar capabilities under development in 10 more states. State investments in Landsat to date total approximately \$28 million. In fiscal year 1980, data sales at the Department of the Interior EROS Data Center were \$2.4 million; the value of Landsat data analysis equipment and services procured from industry is estimated to be over \$35 million.

A new, much more powerful satellite, Landsat-D, is under development and planned to be launched in the third quarter of 1982. This satellite will incorporate a new instrument with seven spectral bands compared to four for the earlier Landsats; improved resolution (30 meters vs. 80 meters for earlier Landsats); and improved sensitivity (256 shades of gray compared to 63 for earlier Landsats). This new instrument, called the Thematic Mapper, will greatly enhance the ability to discriminate features and broaden applications of the data in the disciplines discussed above.

Landsat-D will collect worldwide data by means of the Tracking and Data Relay Satellite System which relays all satellite data to a ground station at White Sands, N.M. From White Sands, the data will be electronically transmitted to GSFC for pre-processing. Final processing and data distribution will be handled by the EROS Data Center. Foreign ground stations will be able to receive data by a direct readout link incorporated on Landsat-D for that purpose. The Landsat-D ground data processing system is designed to decrease data delivery times from several weeks to a few days.

In November 1979, by virtue of Presidential Directive 54, the operational responsibility for civil remote sensing was transferred to the National Oceanic and Atmospheric Administration (NOAA). In consonance with this directive, NOAA will assume responsibility for Landsat-D operations after the space and ground segment are fully checked out by NASA. Presidential Directive 54 further states that NOAA should study ways to involve the private sector in civil and remote sensing activities so that eventually civil remote sensing operations can be transferred to the private sector. The present Administration has emphasized the desire for rapid turnover to the private sector by limiting government expenditures for civil remote sensing satellites to Landsat-D and its backup satellite, Landsat-D'. NOAA is presently formulating a plan to achieve this turnover to the private sector.

CHAPTER III.—NOAA's OPERATIONAL LANDSAT ACTIVITIES

To provide an appropriate perspective, NOAA provided the following summary of their Landsat operational activities:

NOAA was assigned management responsibility for the Landsat D system in November 1979. Current plans are for NOAA to take over operational responsibility for Landsat D in January 1983, after the satellite has been checked out and the ground system has met operational standards for the production of Multispectral Scanner (MSS) data. NOAA will take over operational responsibility for the production of Thematic Mapper (TM) data in January 1985, after NASA has completed the algorithms necessary to produce this data.

Since 1979, NOAA's major focus has been on the analysis and resolution of the policy issues involved in the decision to transfer civil operational land remote sensing from space to private sector ownership and operation. In conjunction with the other interested Federal agencies and with input from non-Federal users and potential private investors, it first prepared the "Transition Plan for Civil Operational Land Remote Sensing from Space" and a public "Issues and Options" document, and then prepared draft legislation which is currently under consideration by the Administration. During the same period, however, it has taken all the steps necessary to ensure the successful takeover and operation of the Landsat D system.

Organizationally, NOAA in 1980 established a new line administration for satellites reporting directly to the NOAA Administrator, and within the new entity established a small staff capability to handle relations with users, both domestic and foreign, and necessary policy and planning activities. In 1981, a small team was created to handle the operational takeover of the Landsat D system from NASA. This team is located at the Goddard Space Flight Center and is working closely with NASA in the final development of the Landsat D system. This team consists of detailees from NOAA's operational weather satellite programs.

To ensure continuing input into the policy issues involved in the commercialization of civil operational land remote sensing from space and NOAA's management of the Landsat D system, the Secretary of Commerce in 1981 established a Federal interagency Program Board for Land Remote Sensing from Space at Assistant Secretary level to ensure Federal coordination in civil operational land remote sensing satellite activities, as well as an Advisory Committee for Land Remote Sensing from Space to advise NOAA on its civil opera-

tional land remote sensing satellite activities. Major user constituencies and potential private investors will be represented.

Additionally, NOAA has conducted five conferences for non-Federal users nationwide to ascertain the services derived from the Landsat D system. Questionnaires distributed at these conferences are being analyzed and a report will be available this fall.

To initiate the commercialization process, NOAA has prepared a proposal to raise the prices charged for Landsat D data and services in fiscal years 1983 and 1984. This proposal is currently under study by the Administration.

NOAA has also taken an active role internationally, participating in regional Landsat user meetings in Africa, Asia and South America to inform foreign data users of products and services available from the Landsat D system, and conducting discussions with foreign ground station operators on increases in access fees and the initiation of other fees.

During the next fifteen months, NOAA will complete arrangements for the operational takeover of the Landsat D system in January 1983. It will complete the permanent staffing for the operational takeover by January 1982. It will sign Memorandum of Understanding with the Department of the Interior and with the National Aeronautics and Space Administration establishing operational relationships with respect to the Landsat D system. Negotiations are already underway. It will procure tape recorders for two additional foreign ground stations to augment the four tape recorders already installed by NASA so that Landsat D MSS data can be acquired prior to the Tracking Data and Relay Satellite System (TDRSS) becoming fully operational.

It will negotiate Memoranda of Understanding with foreign ground station operators covering increases in access and other fees and, in certain cases, the operation of U.S. tape recorders. Finally, it will procure operations and maintenance contract support for the Landsat D system and will prepare for the takeover from NASA of operational responsibility for the production of Thematic Mapper (TM) in early 1985.

CHAPTER IV.—INTERNATIONAL PERSPECTIVE

Civil remote sensing from space has expanded tremendously due to the United States development and leadership which produced the experimental Landsat system and associated technology. Estimates indicate that over 100 countries are involved in some form of remote sensing activity and that over 75 nations have used Landsat data for resource and mapping studies. Today nine nations are currently leasing ground stations to receive Landsat data, and three additional stations are soon to be operational.

One of the most important applications of remote sensing technology is in the area of foreign aid, particularly, in less developed countries where the need for improved information is essential if development is to occur. The United States Agency for International Development (AID) began its remote sensing program by providing 10 seed grants in 1974. Countries that received this initial assistance included Peru, Zaire, Pakistan, Chile and Bolivia. Of the ten original projects seven were successfully concluded. AID's remote sensing activities have grown from this seed program to a three-year 50 million dollar program with activities in 32 developing countries. By utilizing Landsat data these projects are performing vital functions such as crop inventories and estimates, ground water location, geological mapping and resource inventories. AID is also currently active in assisting in the development of remote sensing centers in Thailand and Bangladesh.

The perception of the foreign community is that the U.S. has demonstrated the value of remote sensing from space. As the United States reduces its longer term budgetary commitment to Landsat, four other nations and one multi-national group (ESA) are increasing their programs with plans to launch their own systems during the 1980s:

The *French* SPOT satellite is set for launch in 1984. SPOT will offer 20 meter resolution data to all users, and 10 meter data with the consent of the sensed nation. The French view SPOT as useful for reconnaissance and resource monitoring, for foreign aid, and as a boost to French aerospace and national prestige.

Japan plans a 1987 launch for its Earth Resources Satellite (ERS-1). The Japanese consider Landsat data inadequate for their needs in resource monitoring. This stereoscopic system is a mining industry/government venture for the purpose of locating global petroleum and mineral resources. The Japanese are also planning the launch of a Marine Observation Satellite (MOS-1) in 1985.

The *European Space Agency* (ESA) is planning a two-satellite program—the first of which will be a Coastal Ocean Monitoring Satellite (COMSS/ERS-1) planned for launch-

ing in 1987 to be followed two years later by an Advanced Earth Resources Satellite (AERS).

India has launched two rudimentary remote sensing satellites—one in 1979 and another in November of 1981. Plans include a follow on in 1984 and a more elaborate satellite proposed for launch in the 1984/1985 timeframe.

Soviet Union has flown high resolution camera systems on manned and unmanned missions. The Soviets are also active in the area of meteorology utilizing their "Meteor" spacecraft for this purpose. The Soviets launched an ocean studies Remote Sensing system on their "Cosmos-1076" in 1979 and "Cosmos-1151" in 1980 (several other satellites appear to have the same mission but the Soviets have not announced that they are for ocean resources.) In July 1980 an experimental vehicle was launched with the "Fragment-2" system which is comprised of 170, 80 and 30 meter resolution scanners. This is prototype equipment for a quick look earth resource subsystem.

Additional launches of remote-sensing satellites in the 1980's may occur in Indonesia, the Netherlands, Brazil and China.

France intends to make SPOT an operational civil land remote sensing system. At first the system will be divided into two parts; a space operations segment and a marketing distributor for SPOT data. The French government agency, CNES, will be responsible for providing continuity for the space segment until the system is self supporting. SPOT-Image, a subsidiary of the government, will operate as a private corporation with shareholders from France and possibly other countries. The role of SPOT-Image will be worldwide marketing and distribution of SPOT data and products.

The value of remote sensing data was expressed by the Soviets in a paper prepared for the 1981 meeting of the United Nations Conference on the Exploration and Peaceful Uses for Outer Space:

According to expert opinion at present, the expenditures on the development of remote sensing systems are already repaid, in the coming years the savings will considerably exceed the expenditures, thus justifying a comprehensive acceleration of the efforts to develop space remote sensing.

CHAPTER V.—SUMMARY OF HEARINGS

This chapter presents a summary of the testimony of each witness that appeared before the Subcommittee in the order of their appearance, followed by a summary of each submitted paper.

Mr. Joseph Wright, Deputy Secretary, Department of Commerce, set forth the following major objectives that need to be achieved:

First, we have to make sure that we fulfill the data needs of American users, which does include the Federal Government. Second, we have to be sure that future expansion of the U.S. Land Remote Sensing Satellite industry is promoted, if not guaranteed. And third, we have to sit down and make sure that we satisfy foreign policy objectives.

In closing, Mr. Wright made the following remarks on an approach to private sector involvement and the steps to be taken:

We favor an approach that will promote competition in the private sector. Some legislation will be required for this.

The next step we feel to be taken includes: first, reaching a decision on the type or types of private sector involvement; second, ascertaining the level of interest and the specific type of arrangement. This includes the economics and performance requirements. Third, obtaining an Administration position. And, finally, fourth, working with the Congress on legislation to implement the transfer as soon as possible.

Mr. James M. Beggs, Administrator, National Aeronautics and Space Administration, emphasized the following points:

First of all, NASA is heartily in accord with the idea of moving this into the private sector. Logically, it is the way to go once it has been determined that a market has developed that would support the economic activity involved.

Secondly, if legislation is to be drafted, as it has been in the past, it should be as flexible as possible.

I would urge a fairly permissive, flexible, innovative statute that would permit any number of different alternatives for private sector entry. It should provide permission to sell, donate, or share the Federal Landsat assets. It should provide permission, as Mr. Wright has stated, to engage in either joint ventures, licensing, or possibly giving authority to have a monopoly position for a period of time. And it should waive the necessary antitrust freedom of information and copyright provisions for some period of time.

In conclusion, Mr. Beggs made the following comment pertaining to Landsat market potential:

We think that this venture can be successful and I think that looking at the market, there is a market there. Whether it's of a size to sustain a viable commercial venture at this time, I cannot judge.

Mr. Thomas J. Anderson, National Conference of State Legislatures, made the following points:

The space segment of the system has been developed at vast cost, completely from tax dollars paid by the citizens of this nation. If the Federal Government chooses not to maintain this segment, but rather, turns it over to the private sector, the outcome is obvious: state and local governments would be hard pressed to afford the purchase of data products that are priced to recover portions of this capital investment.

On the other hand, ground data reproduction and distribution segment of the land satellite system appears to have developed a fairly solid foundation.

Only small increases in costs of data products and/or the user community would make this area a profitable venture for private sector firms. It may well be that the time is right to transfer this segment into private hands.

Mr. Bruce Rado, Chairman, Earth Resources Data Council, National Governors Association stated:

Until we resolve once and for all that, as a nation, we are committed to space technology as a means for dealing with resource issues, satellite technology may be nothing more than a missed opportunity.

The uncertain future of land base remote sensing satellites has been a constraining factor in terms of state involvement in the system. Nevertheless, 25 states have developed the capability to analyze and apply Landsat data with investments of over \$27 million and I think very substantial prospects for the future.

Mr. Rado further gave the following system guidelines thought to be pertinent by the states:

That that system not have a negative impact for the launching of Landsat D, that the proposed system provide continuous coverage now and at the close of this decade, that the states be guaranteed access to the system, and that the pricing policies reflect the fact that in the states, we have one-to-two-year lead time in terms of our budget cycles.

In closing, Mr. Rado stated:

Whatever degree of private sector responsibility for operation is ultimately agreed upon, it is the role of the Federal Government to establish the guiding policies and framework.

In conclusion, let me stress that it is critical that the United States have an operational remote sensing system.

If we allow short-range economic constraints to dictate in this case, the long-range implications could be devastating for this nation. It is important that we focus on the policy implications of not having this technology.

While the Office of Management and Budget, through its aggressive Economic Reform Program, has stated its budgetary position with regard to satellite remote sensing, it is time for the Administration to specifically focus on the policy implications. In particular, the Administration should examine the economic and political importance of this technology in the international and domestic arena.

Dr. Norman H. MacLeod, President, American Science and Technology Corporation, presented the following views:

We, as Americans, need more than will to remove, for example, our dependence on non-renewable foreign energy resources. We need as well, information resources which are focused on the discovery, evaluation, management and distribution of these resources.

We must produce a cheap, utilitarian product for every man—that is to say, every nation. Otherwise, as in the case of the automobile, others will do it for us, France with the SPOT, Germany with the ERS 1, the Japanese with the ERS.

In this highly technical enterprise, industry and government have to work together. Our industry must have government support but not in the form of guaranteed markets or grants or subsidies. However, we need the assurance that we will not face competition from our own government.

Dr. MacLeod addressed remote sensing commercialization by stating:

The private sector can find an adequate return in the present free market because we can mount an effective program at approximately an order of magnitude less cost.

Dr. MacLeod, in closing, made the following statement on regulatory needs:

We recognize the need for licensing of the private sector working in areas of public services—to meet treaty obligations, to assure government requirements for data are met, and to assure the national defense and the security of our country.

In these senses, we welcome regulation. But gentlemen, as I've said, we in American Science and Technology Corporation are proceeding with the private sector development of our commercial earth observations systems.

Timeliness is important; indeed, vital to us. We hope that we can be assured that the development of regulations for this new industry will be done with dispatch as well as with regard to establishment of a strong American industry in the international market.

Dr. David S. Simonett, Dean of the Graduate School, University of California, stressed the following points:

This is a revolutionary technology. I think we must be cognizant that the revolution needs to penetrate to the lowest sector of what we can refer to as a pyramid of users.

The second point I would like to make is that pricing and timing issues are crucial with respect to this pyramid of users. And a single price cutting across the pyramid could differentially segregate out a large share of users among whom would be a large sector of the less developed countries.

In the international area, it is important to recognize that, in effect, we have been engaging in a transfer payment to the LDCs by the low pricing that we have used and that it needs to be acknowledged that that has value in itself.

The next point that I would like very briefly to make is a concern with respect to commercialization [and the role of science and research.

In this respect, it is important that the private sector, as they enter into new arrangements, acknowledge the special role in the United States of joint research between the private sector, the Federal Government, and the universities, and some kind of levy mainly to be exercised in order to keep the flow of research going into training young people. It is the cheapest form of research that we have found in the United States.

The final point is that a considerable share of the training of foreign nationals takes place in the United States, and we must bear in mind the differential effects of reduced flow of young people from the foreign LDCs if we, in effect, cut out a share of interest in that area by our pricing schedules.

Mr. Kenneth B. Craib, President, Resources Development Associates, expressed the following views:

First, is that civil land remote sensing has been a reality since 1972, and we have, in fact, had demonstration and pilot projects throughout the United States and around the world. These projects, at least the ones that I have seen, have usually demonstrated cost effectiveness ratios on the order from 1.5 to 10 to 1. And it would then seem a little strange that remote sensing still seems to be a technology in search of a market.

The major concerns that I have seen around the world for remote sensing have been the matter of continuity of data and the price of that data after major funding or system commitments have been made.

Government users face a unitary elasticity of demand for data in which their demand is constrained by available budget. They have a definite incentive to spend whatever budget funds they have established and an incentive not to spend less than what they have.

If the price of data increases, then they do not have the option of obtaining more funds within that particular year. Therefore, they will spend their same dollars, but purchase less total data.

In his conclusion, Mr. Craib presents the problems associated with market evaluations:

We have been told that no one has any idea what the market will bear. I think this is fair. No one has done any studies on the price elasticity of demand for remote sensing data or information. That is certainly a valid point.

We have two ways of finding out what these things are. we can, in fact, let the market decide. We can go ahead and establish a civil service and see what happens. I would wonder what the consensus might be if we find out it is ineffective without government subsidies and have to go back in and do this.

The other thing is we can do market studies, but in the absence of any market experience as to what these data are going to cost and what the real cost of recovery should be, we have to make some assumptions. And as we have seen in a variety of studies done to date, the assumptions you get in any study are a direct function of the assumptions you are willing to live with.

Dr. Michael T. Halbouty, President, Michael T. Halbouty, Inc., summarized his views as follows:

In summary, I am recommending the following: (1) There is a critical need to adequately fund longer term, high-risk but potentially high pay-off fundamental remote sensing research and technology development within the government to capitalize on the tremendous technological advantage that the space shuttle provides; (2) The Landsat system should be declared operational and we should recognize that technology changes in the operational system would occur when proven, low-risk technology is available. Therefore, a level of funding must be established to support that operational status; (3) the single federal agency responsible for land remote sensing and the remote sensing industry should together work out the details regarding the best institutional framework and legal arrangements to ensure maximum industry involvement in the program; (4) the government should be responsible for the high-risk elements of the operational program. This is the state of most of the program now, but the government's share will decrease as technology advances and industry becomes more involved in the operational aspects of the program; (5) industry participation should be encouraged to the highest degree possible by (a) legislation as broad and simple as possible to permit future industry involvement in all types and phases of civil remote sensing activities, and (b) the government bureaucracy should be streamlined so there is a single government agency interface—and I recommend that this agency be NASA; and (6) I want to make it perfectly clear that I consider myself as one of this nation's strongest advocates of the free enterprise system and, sooner or later, I would like to see industry take over as much of the civil remote sensing program as possible,

including ownership and operation, provided there are no guarantees or subsidies from the government, and also that any industry involvement will be consistent with the international policies of the United States, (7) it is imperative the United States launch as soon as possible a solid state stereo capability satellite from which its data would tremendously aid in discovering the energy and mineral resources which are so vital to this Nation as well as to the rest of the world.

In closing, let me say that I believe the Landsat project is the most significant mission ever flown by NASA. The use of Landsat imagery by the mineral and petroleum industries in the United States can improve the nation's domestic resource base in a shorter time and at a more reasonable cost than would be possible otherwise. Therefore, our civil remote sensing program is a national asset and conferring operational status on that program is going to profoundly improve the development of American civilization.

Mr. A. J. Rosenberg, Vice President, General Electric Company, General Manager, Space Systems Division, completed his testimony with the following statement:

Given the size of the identifiable market, the large front-end costs, and the prospect of many years of investment before any recovery can be expected, I have serious doubts that most businessmen would choose to enter land remote sensing as a total commercial venture today, or, if they would, they would be successful financially.

Nevertheless, we can expect continued pressure to recast the system into some kind of commercial enterprise. And I think we should ask ourselves whether pressure alone can suddenly produce answers to questions that have challenged our most knowledgeable and experienced people for virtually the entire life of the program.

We ought to be confident that, given enough time, the issues surrounding the advancement of users' capabilities and their commitment to the system can be resolved; that Government as the dominant data user can aggregate the market and place a credible value on it; and that the proper relationships with the international community—diplomatic, cooperative, and competitive—can be established, including, incidentally, equitable agreements with nations which have their own ground stations.

To rush precipitously into any mode of system transition before this formidable array of issues has been resolved is to jeopardize the investment of the government and the interests of the user community.

It has taken nine years of experimental effort to establish the utility of Landsat. The system represents a billion dollar investment. Prudence and good business judgement dictate that we think of our payoff on a long-term basis.

If the future of the system includes commercial operation or ownership, the provision of data continuity, and a sys-

tematic approach to market aggregation, will be necessary and valuable preparations for the transition. In my view, these preparations will take many years and much dedicated effort.

At this stage, the primary concern should be to preserve the integrity of the system we have and protect our national investment.

Dr. Joseph V. Charyk, President and Chief Executive Officer, Communications Satellite Corporation, made the following points on commercialization :

There is no question that the United States is engaged in a contest with other nations to develop commercial remote sensing applications. The French have begun construction of the SPOT satellite which they plan to launch in early 1984. Of particular value to petroleum and mineral exploration interests, its high resolution, stereoscopic data will be sold through a commercial entity specifically created by the French Government to aggressively expand the commercial market for SPOT products worldwide.

The Japanese Ministry of Industry and Trade has also announced plans to build satellites which would include a high resolution stereoscopic capability, as well as a synthetic aperture radar to measure sea state phenomena of importance with regard to fishing harvests and oil tanker operations.

Users of remotely sensed data in the United States, including government agencies, may have no choice, but to become customers of these foreign programs if commercial U.S. systems using advanced technology are not developed in a timely manner.

Dr. Charyk further stated :

Transfer of civilian remote sensing systems to the private sector will require a cooperative effort on the part of both the Congress and the Administration. From the standpoint of simplicity, prompt action, and assured results, the most effective means by which to effect this transfer is legislation which would designate an appropriate private entity.

In conclusion, Dr. Charyk gave the following summary :

In summary, Mr. Chairman, Comsat urges that a new civilian remote sensing satellite policy be established for the commercialization and transfer of the government programs to the private sector. The keystone of such a policy should be the designation of an appropriate private sector entity to assume the responsibility for the development of a single integrated earth environmental observation system to meet the needs of government and private users.

Furthermore, we believe Comsat is the logical entity to assume such a responsibility. If so designated, Comsat is prepared to proceed to dedicate the resources necessary for the successful development of such a system.

Dr. Ray A. Williamson, Office of Technology Assessment, in a paper requested by the Subcommittee for the hearing record supported a split segment concept for commercialization.

The best way to achieve eventual full private sector ownership of the satellite remote sensing system may be to separate the space and the terrestrial segments into two distinct entities. Each could be commercialized at a different rate. However the transfer is finally achieved, the users clearly wish to have a strong voice in the process.

Dr. Williamson summarized by stating:

It is clear that the user community has experienced considerable frustration in trying to work with the current land remote sensing satellite system. Users are concerned about their future ability to obtain satellite data, for in spite of the problems they have faced, they see the system as an important adjunct to their respective missions as government agencies or private concerns. For them the two most important issues are (1) maintenance of the data flow, and (2) the direct inclusion of their interests in the decision-making process.

Dr. Fred Henderson, President, the Geosat Committee, in a letter submitted for the record, stated:

The areas of participation and definition of private sector responsibilities to best serve the U.S. interests are not yet defined. There are no mechanisms yet to develop a cooperative effort between government and industry to define where such participation and responsibilities should lie. It is appalling that the United States has no mechanisms in this area. All other industrialized countries participating in satellite remote sensing development in the critical areas of energy/mineral resource exploration have such mechanisms.

Dr. Henderson made the following comment on data continuity:

Data continuity must be provided by policy and budget decisions to produce such systems. The current annual effort by the OMB to reduce these data systems must be stopped until the mechanisms are created for the data to be developed within the private sector. In effect, the government policy is clearly short-sighted and not in the national interest.

CHAPTER VI.—MAJOR ISSUES

FOCUS AND SCOPE OF AN OPERATIONAL CIVIL LAND REMOTE SENSING SYSTEM

What resource areas or types of observations, if any, require a dedicated satellite or system of satellites? What areas or types can readily be combined to be serviced by a single satellite or system of satellites?

Mr. Beggs (NASA) :

Many types of resource observations can be and are combined on single satellites or systems of satellites. Factors dictating independent or dedicated systems include requirements for day versus night observing times, such as (a) thermal infrared observations required for geological classification; (b) particular orbital inclinations, such as polar versus sun synchronous; or (c) particular sun angles, which are determined by the time of nodal passage, that are important for crop classification. NASA is currently studying the various system requirements necessary to meet these diverse requirements. Where conflicting requirements of the type mentioned above do not exist, multiple sensors can be combined on single satellites to reduce costs.

Mr. Wright (Commerce) :

No resource areas or types of observations inherently require a dedicated satellite or system of satellites. Technical and cost considerations at this time seriously limit our ability to consider different types of sensors on a single satellite or system of satellites.

Mr. Craib (Resource Development Associates) :

Agriculture requires frequent and repetitive coverage, but has little requirement for stereo data. Geological applications could benefit from stereo data, and do not require as frequent coverage as agriculture. Weather data in general may have lower spatial resolution than is desired for either agriculture or geology.

Dr. Halbouty (Michael T. Halbouty, Inc.) :

Geologists anticipate the development of solid-state linear and/or area array imaging spectrometers with an onboard signal processing capability to permit selection and combination of data from tens of wavelength bands. This should allow a wide variety of users, from agriculture, forestry, landuse fields as well as the geosciences to select coverage of specific sites at high resolutions. Such high resolutions might include spatial resolutions of 10 meters or smaller over 100 km swath

widths with spectral resolution in as much as 100 or more wavelength bands at bandwidths of $0.01\ \mu\text{m}$ or less. At these resolutions, global repetitive coverage is out of the question so geologists, and probably scientists from other disciplines will require continuing global repetitive coverage from a low-resolution sensor like the MSS, to evaluate changing landscape conditions and select sites and times of year for high resolution coverage. High resolution (10 to 15m GIFOV) stereoscopic data could be acquired from the same platform, and perhaps sensor, with a pointing capability.

Mr. Rosenberg (General Electric) :

There are two general areas of commonality in which missions can be effectively grouped. The first is in resolution level. Ten meter resolution has been specified as a common requirement for certain geologic, small-scale agricultural and land use planning missions. Thirty meter resolution is thought of as an adequate level for large-scale crop prediction, hydrologic, forest management, and land use missions. Eighty meter resolution is satisfactory for synoptic surveys of a wide variety of resource missions. Appropriate combinations may thus be possible and practical.

There also may be opportunities for mounting multiple missions on single platforms if the requirements for frequency of observation are compatible. Certain geologic, agricultural, and hydrologic phenomena, for example, can best be observed on a seasonal basis, while crop prediction and environmental missions could require observations every few days. Such commonalities in mission requirements will determine whether dedicated satellites or combined platforms would be the most necessary and efficient system configurations.

Dr. Charyk (COMSAT) :

Satellites are necessary to observe global and/or synoptic environmental resources. The number of platforms used and their precise orbits are based on the synoptic time scale of the events to be monitored and the type of sensor being used. Sensors with multiple applications can be combined on the same platform. Thus, weather, sea condition, and high resolution land images will be combined in the future in much the same way that COMSAT intends to combine the ground systems now.

Dr. Simonett (University of California) :

These questions have not been asked generally of the scientific community, or ever addressed adequately within NASA. The answers will change and mature with our understanding of the problem. A study underway by Frederic Billingsly of Jet Propulsion Laboratory attempts to combine uses on a single satellite through the following procedure: (1) Find the altitude at which a series of coverages can be met. These will include, (2) Frequent (9-day) coverage with relatively coarse resolution multispectral remote sensing for agricultural and

hydrological purposes, (3) three-monthly, intermediate-resolution multispectral sensing for seasonal natural resource sensing (forestry and some rangeland applications), and, (4) six-monthly to annual sensing with very high resolution single-channel imaging (needed to meet some geologic applications). Very little of this type of analysis (which is required to address Congressman Flippo's question) has been done. Another recent example is a study by General Electric Corporation looking at future earth-synchronous satellites which could be used for resource sensing. Such satellites could clearly be combined with earth-synchronous meteorological satellites. Recent studies of radar satellites suggest that most short and long term resource needs covering agriculture, hydrology, and geology, might reasonably be met by observations from satellites in tandem, in parallel orbits. Since our ability to postulate future systems and satellite altitude, orbit and time repeat-time characteristics are only now being explored, it is likely that some very interesting and worthwhile combinations may be achieved. I believe the answer is generally favorable to combinations of instruments on a single satellite to address multiple needs.

Could weather satellites be combined with land sensing satellites in an effective system? Could they be combined with communication satellites?

Mr. Beggs (NASA) :

Data from weather satellites would be useful in programming sensors which require data in the visible and infrared regions of the spectrum to avoid acquiring useless data in cloud covered areas. The combination of these sensors on a single satellite in low Earth orbit may prove difficult because of the different sun angle requirements for accomplishing the necessary measurements. It would be possible to combine geosynchronous orbit weather satellite instruments on the same bus with communications transponders. However, the required location of these satellites in the geosynchronous arc, east and west of the United States would be nonoptimal for communications purposes.

Mr. Wright (Commerce) :

While polar orbiting spacecraft could be designed to accommodate both land and weather sensors, the price would be substantial, perhaps running into several hundred million dollars (exclusive of sensors). A new generation of land sensors (multilinear array) would have to be developed and tested to reduce the weight and power requirements of the electro-mechanical sensors, and compromises that might be less than satisfactory would have to be made on orbit selection and equator crossing times for remote sensing of both the land and the atmosphere.

Such a change in satellite operational characteristics would further diverge the civil and military polar orbiting weather satellite systems, thus eliminating the economic benefits now

experienced by both programs through the use of common spacecraft. In addition, the operator of such a system would run the risk of losing both sets of sensors in the event that the spacecraft was lost. With different spacecraft the risk is spread. Finally, the useful life of our weather sensors is currently 20 months whereas the Landsat D spacecraft and sensors have an estimated 3-year useful life. If combined on a single spacecraft, the entire craft would have to be replaced when the component with the shortest life failed.

The functions now being performed by the GOES satellites theoretically could be continued by placing GOES sensors on geostationary communications satellites. However, it is not clear whether this approach would be cost-effective. A new generation of weather sensors would have to be developed because GOES are spinning satellites and the communications satellites are not. In addition, a new spacecraft large enough to carry communications equipment and an environmental sensor would have to be developed. Finally, as with the polar satellites, there is a problem of disparate equipment lifetimes. Environmental imaging sensors now have a lifetime of three to five years, while communications equipment lasts seven or more years.

Dr. Halbouty (Michael T. Halbouty, Inc.):

It is doubtful that weather satellites could be effectively combined with land remote sensing satellites in an effective system. Weather satellites must provide data almost continuously and thus should be in geosynchronous orbit. Much scientific research of long-term nature will have to be done before weather satellite data can be used for its intended purpose—weather prediction and climate change monitoring. Observations of weather require very coarse resolution (1–10 km IFOV) when compared to land observing systems. Land observing systems need to orbit the earth in near polar, low altitude (less than 1000 km) orbits to maximize ground resolution. There is no need to combine the weather satellite program with the communications satellite program. The weather satellite program is a high-risk, long-term scientific research program in which the government is the major benefactor. The communications satellite program is a highly applied program managed by industry with the private citizen and private industry as the major benefactors. To mix these two programs makes no sense whatsoever, and it cannot result in any economy.

Mr. Rosenberg (General Electric):

The frequency and resolution factors cited above would be operative in considering combinations of weather and land sensing satellites. Effective weather forecasting, particularly the tracking of large systems, requires several observations daily at large scale and relatively low resolution. Such fre-

quency and resolution would be of little utility in agricultural, geologic, or land use planning missions, for example. Thus, although it is theoretically possible to perform weather and land sensing missions from a single satellite, or even through a single sensor, the range and versatility of such observations could be so severely compromise as to be impractical for either mission.

Since efficient satellite communications are best supported by satellites in geosynchronous orbit, any attempt to mount land remote sensing missions on communications platforms would necessarily encounter severe problems with resolution, in addition to the obvious limitation implied by their fixed perspective and limited view of the earth's surface. Within the existing state of the art or the anticipated improvements in land remote sensing, it is difficult to see any advantage in trying to combine this mission with the communication mission. There may be advantages, however, in using future geosynchronous communication platforms as relay points in the transmission and distribution of land remote sensing data.

Dr. Charyk (COMSAT) :

Yes. COMSAT has studied ways to improve services and reduce cost by consolidating satellite and ground systems.

What is your opinion of the present status of Landsat? Is it ready for operational use?

Mr. Beggs (NASA) :

The Landsat system presently in service (LANDSAT-2 and -3) was implemented for research and develop (R&D), not operational service.

Mr. Wright (Commerce) :

The current system consists of two spacecraft that have lasted beyond their design lifetime and are now able to support a limited mission only, and a ground system that has evolved from a R&D design. Such a system cannot form the basis of an operational system. The limited amounts of data now gathered are being handled and the backlog of previously acquired data is being reduced, but an operational mission is not being met.

Mr. Anderson (National Conference of State Legislatures) :

The current Landsat system is definitely ready for operational use. The states, in fact, have been making many, many operational uses of the experimental system for several years. I would refer you to an NCSL report, "State Applications of and Investments in Landsat Technology," a copy of which has been provided to the committees' staff, for an inventory of the near 600 applications projects undertaken by over forty different states. This report also documents nearly \$30 million in state Landsat investments, many man-years of effort expended, and a great deal of data purchased.

Mr. Rado (National Governors Association) :

Landsat is now ready for operational use. It has demonstrated value for agricultural crop monitoring, irrigation inventories, flood and wetland mapping, major facility siting, and mineral exploration. Landsat is operational in fifteen states and ten additional states are developing operational capabilities.

Mr. Craib (Resource Development Associates) :

Operational implies that data be reliably and regularly available. The present Landsat system may be "ready" for operational use but is not now an operational system.

Dr. Halbouty (Michael T. Halbouty, Inc.) :

Yes, the MSS should have been declared operational when Landsat-2 achieved orbit and the sensor operated to specifications in 1975.

Dr. Charyk (COMSAT) :

Currently operating LANDSAT satellites must be considered unreliable for providing continuous data to operational users. Landsats 2 and 3 are providing some data, but there is a serious question as to their longevity.

What is the applicability of Landsat-D to an operational system?

Mr. Beggs (NASA) :

The Landsat-D and -D' system is being developed as an operational system insofar as the Multispectral Scanner (MSS) and its associated ground data processing is concerned. It has redundant processing lines and maximizes the use of off-the-shelf, highly reliable hardware. The ground system has been designed for 48-hour response to user requests at a confidence level of 85 percent, averaged over a ten-day period. The primary operational sensor on board the Landsat-D and -D' spacecraft is the MSS, an instrument type which has a ten-year operating history in which it has always greatly exceeded design life. There is every reason to expect that the system will perform as a satisfactory operational system well into the late 1980s.

Mr. Wright (Commerce) :

NOAA will begin to manage Landsat D as an operational system after NASA has launched the satellite and fully tested its ground system. NOAA is scheduled to assume operational responsibility for the Multispectral Scanner on Landsat D early in 1983 and for the Thematic Mapper after it has been thoroughly tested, probably in 1985.

Mr. Rado (National Governors Association) :

The improved sensing and higher resolution capabilities promised by Landsat D will increase the marketability of the system. It is important that we build into any operational

system the flexibility to incorporate new technologies as they become available. The current capabilities of Landsat are limited though important. Landsat D addresses some of those limitations.

Dr. Halbouty (Michael T. Halbouty, Inc.) :

The MSS should be designated as operational now and its data handling system upgraded from experimental to provide data on an operational basis. The Thematic Mapper will remain experimental until NASA thoroughly calibrates its data and develops procedures for proper geometric display of TM data. Once TM data are thoroughly understood by NASA and users then probably when Landsat-D' is launched the TM system should also be designated as operational and be upgraded to provide data on an operational basis.

Mr. Rosenburg (General Electric) :

Landsat-D was conceived as a quasi-operational system fully capable of supporting transition to fully operational status. I see no reason to change this conception of the system's capability.

Dr. Charyk (COMSAT) :

The Landsat-D satellite has both a multi-spectral scanner sensor and a thematic mapper sensor. The multi-spectral scanner sensor can be put into operational use almost immediately. However, the thematic mapper sensor is highly experimental at this stage and faces serious and fundamental design problems. The thematic mapper sensor cannot be considered to be operational at this time since there is no assurance that it will work in a satisfactory manner. The operational potential of the thematic mapper sensor is very high, however, and if it proves to be a successful instrument, it could be incorporated into an operational system.

Landsat-D will provide the best multi-spectral high resolution imagery heretofore available and should greatly improve data available to industries and governments with petro-mining, land use, hydrographic, arctic commercial exploration, and agricultural interests. Landsat-D will also introduce several engineering and technology innovations that will improve data registration, recovery, and overall utility and, with private ownership and operation could be considered the first step in an operational land remote sensing system.

Dr. Simonett (University of California) :

A two-satellite Landsat-D system, containing both the multispectral scanner and the thematic mapper, would be particularly useful for agricultural sensing and could bring improvement to virtually all other applications sectors. However, the higher resolution and the additional channels of the thematic mapper would produce a sharp increase in data rate from 15 to 110 million bits per second. This would

impose significant additional requirements on the ground-based data reception and data processing sub-systems and on the processing employed by all applications users. The multispectral scanner carried with the thematic mapper would serve the needs of receiving station and users not yet prepared to shift to the more advanced technology and would retain comparability with earlier Landsat data and could serve as a backup to the untested thematic mapper. For all of these reasons Landsat-D is very applicable to a potential operating system if the multispectral scanner is included on Landsat-D. At the same time having the thematic mapper and the multispectral scanner carried together on the same spacecraft would facilitate bridging to the more sophisticated system.

Considering the total system, space segment and ground segment, do you think we have adequate assurance of timely and uninterrupted service through the late 1980's with the present approved program?

Mr. Beggs (NASA) :

To maximize timeliness of data delivery, ideally, the system should be designed and developed from the start as a high-reliability, high-volume production system with quality checks on 100 percent of the data products. The Landsat-D system will approximate that kind of performance. In order to insure the effectiveness and efficiency necessary to respond to user demand in a timely manner, highly reliable, state-of-the-art components should be utilized, and redundant data processing lines are necessary. An adequate number of trouble-shooting and data quality check subsystems is also essential. Again, the Landsat-D ground system will meet those requirements. Although our confidence in the space segment is high, there would be delays in reestablishing service in the event of premature spacecraft failure.

Mr. Wright (Commerce) :

The program will provide a one satellite system with a backup satellite available on a 90-day call-up through the mid-1980's, and a ground system that meets an 85 percent confidence standard that all data will be processed and made available within 48 hours of receipt when averaged over 10 days. Users have told us that the planned system will adequately meet their needs.

Mr. Rado (National Governors Association) :

We do not feel that we have adequate assurance of timely and uninterrupted service through the late 1980's. It is our view that if action is not taken immediately, there is no certainty that there will be a system in this country at all beyond the late 1980's. This is critically short-sighted.

Mr. Anderson (National Conference of State Legislatures) :

Additional spacecraft will be required to have adequate assurance of timely and uninterrupted service through the

late 1980's. The original fiscal year 1982 budget contained funding for a third and fourth Landsat-D spacecraft, and their elimination in the revised budget was, I feel, a mistake we may pay for in five years or so.

Dr. Halbouty (Michael T. Halbouty, Inc.):

Absolutely not! The present program is in a shambles. It is split between three agencies and all three are underfunded to correct the problems with data delivery. That is, to deliver at least MSS data in an operational manner. NASA should be designated the sole government agency for civil land remote sensing and NASA should work directly with industry in defining industries role in the operational aspects of the program. The government must oversee land remote sensing because it is a national asset. The government must conduct the high-risk, longer-term, but potentially high pay-off aerospace remote sensing research and must ensure that the required data are delivered to users in standardized scales, accuracies and formats, and in a timely manner. By so doing, the government is providing a guarantee users of the data, but it is not providing any guarantees or subsidies to industry to participate in the program.

Mr. Rosenberg (General Electric):

In my opinion, we do not. Landsat 1, 2, and 3 have provided a total of 13 years of beneficial service. While Landsats D and D Prime may give a similar performance, there is a large and, in my opinion, unwarranted element of risk in basing the future of the program on an assumption that they will. A launch anomaly, a failure or degradation of the Thematic Mapper (as yet an untried system), or failures in the new system for data transmission through the Tracking Data Relay Satellite may interrupt or degrade the service. In my view, the risks are high enough and the consequences of failure serious enough to warrant the provision of additional satellites to guarantee data continuity through the 1980's.

Dr. Charyk (COMSAT):

No. Landsat-D is planned for launch next fall, and it is unlikely that it and Landsat-D' will provide service through 1980's. However, Comsat has studied ways to continue and improve a Landsat-type service.

ISSUES PERTINENT TO GOVERNMENT/PRIVATE SECTOR ROLES RELATING TO COMMERCIALIZATION

By what process should responsibility for remote sensing move to the private sector?

Mr. Rado (National Governors Association):

An equitable competitive process should be established. Major users should agree in advance on the minimum necessary for any owner operator to adhere to. It is important

that this process not get bogged down in long drawn out irrelevant procedures however. Timeliness is critically important.

Dr. Halbouty (Michael T. Halbouty, Inc.) :

PD-54 should be immediately rescinded and NOAA should be removed from the program. Management of the government aspects of the program should be placed under NASA and this includes the EROS Data Center operation. The MSS system should be immediately declared operational and upgraded to provide data on an operational basis. NASA should entertain proposals from industry on the upgrade and operation of the MSS data processing and distribution system. When the TM is successfully tested on Landsat-D, NASA should entertain proposals from industry to upgrade the TM from an experimental basis to provide TM data an operational basis. Industry and NASA should work together in the future to define high-risk, longer-term, but potentially high-payoff research to be conducted by NASA and low-risk elements of more proven technology to be developed by industry.

Mr. Rosenberg (General Electric) :

The only fair and equitable way to move this responsibility is through open competition for ownership and/or management of the entire system, rather than through any processes involving exclusive negotiations or segmentation of system responsibility. However, because of the uncertainties of the market, and the immense risk the purchase at any realistic price would involve, I have doubt that a valid competition could be held at this stage of the system's development.

Dr. Charyk (COMSAT) :

We believe that the most expeditious means of implementing such a policy would be to designate by legislation an appropriate private entity with a proven record of performance, both domestically and internationally, to assume the responsibility for operation of the civil remote sensing system and the evolution of an international system.

Do you believe that the private sector could successfully operate both the space and ground segments on an operational system (leaving aside the question of finances) ?

Mr. Beggs (NASA) :

Undoubtedly, the private sector could successfully operate both segments of an operational system, since the operation of the current system is carried out by private companies under government contract.

Dr. Halbouty (Michael T. Halbouty, Inc.) :

Yes. If the private sector were responsible for operational delivery of MSS data to users, then it will want to control MSS data acquisition to eliminate unwanted data. However,

in the Landsat-D time frame, it may not be necessary for industry to control the platform, particularly if the government is testing other sensors on that platform. Government should encourage industry to manage as many of the segments of the land observing system as industry is willing to operate, but the government should recognize that industry may not want to manage high-risk technological elements and that it will be in the national interest for the government to support these elements.

Mr. Rosenberg (General Electric) :

The General Electric Co. has performed for nine years the essential management and technical tasks necessary to support both the space and ground segments of an operational system, with the exception of the launch. From this experience, I can affirm that a number of private sector organizations could fulfill all the management and technical requirements for an operational system. Fulfilling the financial requirements, however, would be a formidable task for any organization which must answer to its stockholders.

Dr. Charyk (COMSAT) :

We believe that it is absolutely essential that a private sector owner/operator handle both the space and the ground segments of an operational system. Comsat operates both of these segments now for satellite communications and believes strongly that control and responsibility for an end-to-end system is essential to system performance and ultimate customer satisfaction and acceptance. The purpose of a remote sensing satellite system is the production of useful data. Therefore, the system must be designed and operated in a manner which will provide the most efficient production of the most valuable information product. Separate operational authority for the space and ground segments would destroy the system concept and defeat the goal of providing a high quality, efficient service.

Is a monopoly necessary for private sector operation of a Civil Land Remote Sensing System? Would a monopoly have any detrimental effects? If so, what would they be?

Mr. Beggs (NASA) :

Some potential owner operators have argued that a monopoly, at least as to raw data products, is necessary in order to induce any commercial organization to make the necessary investment for system operation. Others have indicated a willingness to invest in remote sensing systems even if there is significant domestic and foreign competition. Multiple industries are expected to participate in the value added segment of the market. Disadvantages of a monopoly operation include possible business failure by the operator which could provide a major break in data continuity, increased likelihood of higher prices, less market responsiveness, and curb on future industry growth.

Mr. Wright (Commerce) :

As I stated in my testimony, "unless there are compelling reasons to select a different alternative, we favor an approach that will promote competition in the private sector." We also want to encourage competition in both the data acquisition (space) and pre-processing (ground system) segments to the maximum extent possible. The disadvantages of a monopoly here, as in any industrial sector, are the increased likelihood of higher prices, less market responsiveness, and curbs on future industry growth.

Dr. Halbouty (Michael T. Halbouty, Inc.) :

A monopoly is not necessary for private sector participation in a Civil Land Remote Sensing System. Monopolies should be avoided because they do not fully stimulate growth and development of the gross national product.

Mr. Rosenberg (General Electric) :

If by "monopoly" we mean the designation by competitive means of an entity as the sole agent of the U.S. Government, with exclusive rights to the government-sponsored market and protection from competition by the Government, the answer is yes. Such a monopoly would not only be necessary for efficient operation, but adequate protection of the private sector investment in such a venture would be impossible under any other conditions.

If such a monopoly would be granted in such a way as to encourage active market development and applications advances by the entrepreneur, it is unlikely that any detrimental effects would result. If, however, such an arrangement entitles the system owner to a continuing subsidy, to be paid irrespective of progress in market or technology development, the most likely result would be stagnation of the system and the danger of inroads by foreign competitors such as the SPOT system.

Dr. Charyk (COMSAT) :

A single owner of an integrated remote sensing satellite system is necessary in order to achieve the potential economies and efficiencies of a combined system. We propose to combine the satellite control functions and the data handling functions as soon as possible. The combination of these functions will make it possible to eliminate the costly duplication of facilities, equipment, and personnel which currently exists because of the split agency jurisdictions in the NOAA/GOES and Landsat programs.

A single owner of an integrated system is also desirable from the standpoint of national security. It is desirable to establish certain responsibilities and controls by the President over any remote sensing satellite system in times of national disaster or emergency. A proliferation of remote sensing satellite systems owned and operated by a variety of

persons at diverse locations would make the exercise of this responsibility more difficult.

A single owner and operator of an integrated system will require some protection, for a limited time, of the investment needed to acquire Government equipment and facilities. The Landsat system is extremely costly and not currently designed for operational efficiency, largely because it was designed as an experimental system. Furthermore, it is technologically stagnant. The purchaser of this equipment must have some protection against operators who would provide specialized services directed toward clients with the greatest ability to pay at least until such time as the owner has an opportunity to install or bring into service more efficient, economical, and technologically up-to-date satellites, equipment, and facilities.

The private owner and operator will also need some time to develop the commercial markets for remotely sensed data. This market development will require a substantial investment which should be protected at least for the lifetime of the Government satellites.

How much guaranteed government business or assistance would be required to enable the private sector to assume major responsibilities for an operational system? Would government subsidies to an existing system have the effect of diminishing competition and, thus, inhibiting innovation?

Mr. Beggs (NASA):

It is difficult to estimate the requirement (if any) for "guaranteed government business" since this would be a function of the type of operation proposed and the amount of risk capital involved. A major factor would be whether the commercial operator runs only the existing system or whether the operator is encouraged to set funds aside to develop next-generation systems.

Mr. Wright (Commerce):

At this time we cannot state with certainty how much guaranteed government business or assistance would be required to enable the private sector to assume major responsibilities for an operational land system. At least one interested company has indicated that a guaranteed data purchase contract with the Federal government is a prerequisite to its assumption of responsibility for the land system. However, other companies have not requested a government guarantee but instead want assurances that the government will not compete with their efforts. Some companies have requested other forms of financial assistance such as favorable depreciation allowances.

Continued government subsidies to the existing Landsat system would have the effect of diminishing competition and thus inhibiting innovation. For this reason, the Administration has decided that it will not continue to subsidize procurement of land remote sensing satellites after Landsat D and D'.

Mr. Craib (Resources Development Association) :

To date, no adequate studies have been done of the market for earth resources data, nor of the price elasticity of the demand for these data. It seems premature to discuss the amount of any government subsidy for services in the absence of definitive information concerning the demand for these services.

Dr. Halbouty (Michael T. Halbouty, Inc.) :

There should be no guaranteed government business or subsidies to the private sector for operating low-risk elements of the operational system. There is no question that government subsidies diminish healthy competition and inhibit innovation.

Mr. Rosenberg (General Electric) :

Since the size of the government market, and the frequency, resolution, and turnaround requirements of the service to be provided are unknown, it is difficult to even estimate how much guaranteed revenue from all sources would be required to sustain an operational system. It is this uncertainty which has inhibited the private sector from specifying the dollar amounts of guarantees required for a feasible venture. In the absence of such concrete information, it would be difficult to determine whether any given level of government support should properly be called a "market guarantee" or a "subsidy."

If competition for initial ownership is diminished, it would more likely be attributable to market uncertainties and the prospective cost of technical development and innovation, rather than to the possibility of a subsidy per se.

Dr. Charyk (COMSAT) :

There will be a significant economic benefit to the Government of combining the meteorological and land sensing programs. The Government market for meteorological data is very well developed with some potential for commercial sales.

The Government need for land data, however, is not as well defined and the commercial market not at all developed. The Landsat system, however, could not be operated commercially by itself without a charge to the Government for data which would be substantially out of proportion to the cost of data to commercial users, e.g., at present, the Government pays for everything except the cost to non-Government users of reproduction of the data even though the Government uses only about 60 percent of the data produced.

By combining the meteorological and land systems, an operator could assume ownership and operation of the Landsat system for incremental costs and use the meteorological business to leverage the development of the market for Landsat data.

Is a copyright provision necessary for private sector operations?

Mr. Beggs (NASA) :

Copyright provisions or equivalent protection for data are almost surely necessary to successful operation by the private sector.

Mr. Rado (National Governors Association) :

A copyright provision would be necessary for private sector operations. It would be impractical for a private corporation to take over a system if the products to be sold were Xeroxed and resold. There is no profit in having the system if there are no proprietary rights to the products.

Mr. Rosenberg (General Electric) :

A copyright provision is absolutely necessary for private sector operation to protect the investment of an entrepreneur in the same way that the publishers of books and recorded music are protected. Such copyright provisions, however, may be difficult to enforce if foreign entrepreneurs operating in cooperation with their governments are able to offer data acquired through the operation of foreign-owned systems.

Dr. Charyk (COMSAT) :

Copyright protection is essential as a part of the framework within which the commercial viability of a remote sensing system operated by the private sector can be achieved. While no significant changes to the existing copyright laws are required by the contemplated arrangements, the unique nature of the data, data products, and institutional framework make certain clarifications essential to provide a clear legal framework within which the data can be protected.

Is the concept of nondiscriminatory data access compatible with the private sector involvement? How important is this concept?

Mr. Beggs (NASA) :

We believe the concept of nondiscriminatory data access is compatible with the private sector involvement. This assumes that "nondiscriminatory data access" means that the raw or preprocessed data products will be available to all who wish to purchase at the same price. Of course, market prices would reflect any value added in collection processing or distribution. If one assumes the term "nondiscriminatory data access" means that all who wish to purchase data can purchase it at a price low enough to make its use for any desired purpose economically viable, then sales at a price low enough to support projects of marginal value would be too low to support the costs of the commercial operator.

Mr. Wright (Commerce) :

We believe that the concept of nondiscriminatory data access is compatible with private sector involvement because (1) no company with which we have spoken has indicated

that this concept is incompatible with private sector involvement; (2) given the large capital investment in land satellites, we expect that a company would want to recoup its investment through sales of data to all buyers; and (3) this concept does not prevent a company from recovering a return on its investment and charging what the market will bear.

This concept is important to ensuring that U.S. foreign policy objectives, including preserving the U.S. "open skies" policy, are met. If the United States can tell buyers in foreign countries that they will have non-discriminatory access to data from U.S. land satellite systems, this will not only help the U.S. balance of payments but also may work to preclude the imposition of more restrictive policies for treatment of remote sensing data by the Group of 77 members of the U.N. Committee for Peaceful Users of Outer Space (COPUOS).

Mr. Rado (National Governors Association) :

The concept of non-discriminatory data access is compatible with private sector involvement. A company can establish reasonable pricing policies and sell the data on an equal basis. While there is some speculation that a non-discriminatory policy would be a disincentive to private sector users, this is not substantiated. A policy of discrimination would have severe consequences. It would put public and private institutions against one another. It would also potentially put public agencies against each other. It is in the public interest to maintain a policy of non-discrimination toward the access of information. Decision making in the public sector has got to be based on reliable information. To impose constraints on our ability to develop the data bases needed to make sound policy choices is unnecessary.

Dr. Simonett (University of California) :

Our policy in the past might more properly be stated as being one of non-discriminatory distribution of subsidized data. A question now before us is whether a move to the private sector will cause prices to escalate to the level of what a full cost recovery procedure would entail, if present U.S. Government costs prevail. In moving to the private sector, we naturally expect costs to be reduced, and cost recovery to be for this lesser figure. However, even with a lesser increment than is posed with full recovery at Government rates, a question which I raised in my verbal and written testimony is the effect of a rapid and substantial escalation of costs on selected parts of the user community. The possibility exists of turning off that community. In my testimony, I considered developing countries, U.S. universities and state and local governments. All will certainly be able to absorb some increase in costs. If it is too large too soon it will have serious impact on all three groups. The advantage of a uniform rate

is its ease and simplicity of application. As far as I can see, that is its only advantage and there are substantial disadvantages of the type mentioned above which flow from such a policy. To summarize, I believe the policy should be non-discriminatory with respect to open access to anybody in the world obtaining the material. If feasible, a differential rate and time staggered schedule of charges should also be established.

Dr. MacLeod (ASTECH) :

Withholding of open distribution for commercial, not security, purposes, may have a temporarily limited virtue. However, as the American oil and mineral industry has found, it is their own precision special processing of data that reveals the most commercially valuable information. Again, a determined searcher will sooner or later find out the information; it is better there should be productive, amicable commercial relationships.

Open distribution of data has other positive values; the management of natural resources usually operates at several mapping scales. Those of earth observations and meteorological data (1:1,000,000 to 1:80,000,000) are the scales of major resource systems, such as drainage basins, mountain ranges and estuaries. Very frequently these are international in scale, and represent international resource management scales. As this is so frequently the case, we find that Landsat data itself has an international character which is flawed (in use) by withholding data. On the other hand the open distribution of data has often served to provide a common technical basis upon which politico-technical problems, may be solved.

Dr. Halbouty (Michael T. Halbouty, Inc.) :

Non-discriminatory data access is compatible with private sector involvement. Anyone, any group, or agency should be able to buy the data. Special data services, such as rapid delivery, should be provided to investors or to those who are willing to pay extra for them, but ultimately data should be available to all users especially if it is acquired over foreign territories and U.S. Government equipment or facilities are in some way involved in data acquisition. Data should not be distributed in a manner which will support aggression against third parties.

Mr. Rosenberg (General Electric) :

If an entrepreneur could establish the value of the data to each user individually, and determine that each would be willing to make payments commensurate with that value, distribution and marketing of data on a discriminatory basis might be practical. The legislative and regulatory difficulties of any discriminatory system, however, could present substantial problems to any entrepreneur. Non-discriminatory marketing policies are more in keeping with commercial practice in the U.S., and could be done without any substantial modification

to existing laws and regulations. It is this practice which has fostered the growth in utility and value of the data to a wide community of users, and has maintained the technological leadership posture of the U.S. in remote sensing.

Dr. Charyk (COMSAT) :

We believe the concept of non-discriminatory access to data is completely compatible with private sector involvement and highly desirable from a commercial standpoint. As you know, the United States has been very successful in preventing attempts by some third world and eastern block countries to impose international controls on the acquisition and dissemination of data. This success is due, in large part, to the policy of the United States of non-discriminatory access to data. The transfer of the United States civil remote sensing activities to a private corporation will undoubtedly be watched closely by other nations. However, as State Department representatives have previously testified before Congress, most countries will not be concerned whether the U.S. Government or a private company conducts the remote sensing, as long as the data policy remains unchanged. However, a change in the policy of non-discriminatory access to data could result in the passage of the measures we have so long resisted, with extremely unfortunate consequences for a business entry.

Suppose that in the future an independent company funded and launched its own satellite. Should they be allowed to restrict data access, i.e., to have proprietary rights to data? What would a landowner's or foreign nation's rights be?

Mr. Beggs (NASA) :

If a private organization created its own satellite system for resource observations, not to be in the business of marketing the acquired data but rather to use the information it could derive from the data, then it would certainly have proprietary rights to the derived information. Such an organization might wish to recover some of its costs by marketing the raw or preprocessed data acquired from the system. We know of no reason why proprietary rights in this data would not exist through normal copyright procedures. It would, of course, be necessary that the operation be conducted consistent with the international obligations of the U.S. Government.

Mr. Wright (Commerce) :

In the absence of domestic legislation establishing the policy of non-discriminatory access, we do not believe that a U.S. landowner would have any right to demand access to data from privately-owned land satellite systems. Although the United States is a party to the 1967 Outer Space Treaty (which states the principle in Article I that "the exploration and use of outer space . . . shall be carried out for the benefit and in the interests of all countries"), the U.S. position has been that this treaty does not compel nondiscriminatory access

by all nations to all land remote sensing data collected from outer space. The Group of 77 disagrees and has pushed in COPUOS for a set of "legal principles on remote sensing" to establish the rights of foreign nations to access data about their territory and natural resources on a priority basis.

Dr. Halbouty (Michael T. Halbouty, Inc.) :

If an independent U.S. based company funds, develops, launches, and acquires data over U.S. territory with its own system, and uses no government equipment then that data could be proprietary if the company desires it to be. There are lots of precedents for this. If an independent U.S. based company acquires data over foreign territory using its own equipment and uses the data for its own purposes then the data could be proprietary. However, if the U.S. based company sells data acquired over foreign territories to other companies, individuals or foreign governments then the company should abide by the international policies of the U.S. Government—that is, data distribution should be non-discriminatory and consistent with the "Open Skys" policy. Congress should avoid legislating these issues, they should be handled on a case-by-case basis because each case is different.

Mr. Rosenberg (General Electric) :

Under the existing concept of international law and common commercial practice, an independent company which obtained scenes of an area of the Earth from its own satellite would have the same proprietary rights as a commercial photographer does in photographs he takes of any scene generally accessible to the public. This includes copyright and proprietary rights in sales and distribution.

The rights of landowners and foreign nations are more ambiguous, but the most commonly accepted concept is that space at altitudes in the Landsat regime is not subject to national or private jurisdiction, and thus no territorial or property rights exist in space any more than they do on the high seas. It is possible, however, that treaties or U.N. protocols may define this more closely in the future, and that international agreements setting forth individual and national rights to space-acquired data may be drawn.

Dr. Charyk (COMSAT) :

We do not believe it is good public policy to allow restrictions on the access to data obtained by a remote sensing satellite system, except for national security or foreign policy reasons. We know of no internationally agreed upon principle which establishes any right in remotely sensed data by the sensed nation or the sensed landowner.

How should a private sector operator be regulated, if at all?

Mr. Beggs (NASA) :

Necessary constraints on operation of the system, such as protecting national security, could be written into any result-

ing agreements. Existing laws are sufficient to cover other restrictions or policy provisions.

Mr. Wright (Commerce) :

As I stated in my testimony, "some minimal government supervision" of a private sector operator may be necessary to ensure that the United States attains its foreign policy objectives, protects its national security and complies with the 1967 Outer Space Treaty. The level of regulation may depend on the degree of competition in the land remote sensing satellite industry. A monopoly would require greater government oversight than a more competitive industry.

Mr. Rado (National Governors Association) :

A regulatory framework should be established to guarantee equal access to data and to assure fair pricing policies. It should not be so prescriptive as to inhibit private sector interest in taking over a system.

Dr. Halbouty (Michael T. Halbouty, Inc.) :

Regulation of the private sector should insure that data is provided in standard scales, accuracies, and formats. The government should also ensure that there is no overlap in data transmission links and that international policies, where appropriate, are adhered to.

Mr. Rosenberg (General Electric) :

Adequate precedents exist for regulation of the activities of any private sector operator. The operator, if able to overcome the market and investment difficulties inherent in commercialization, would probably function as a franchised service with provisions more or less as follows:

1. He would be protected from competition.
2. He would be required to provide a given level of service.
3. His pricing policy would be restricted to agreed limits.
4. He would be restricted from expansion into other fields of technology or missions.
5. He would be responsive to a quasi-public board, most likely composed of users, which would have some voice in significant system operations.
6. His performance would be subject to periodic review by cognizant Government authority.

Dr. Charyk (COMSAT) :

To the extent that any regulation is required, we believe that it could be accomplished through a contract between the Government and the operator which governs the procurement of remotely sensed satellite data and products and through the oversight responsibilities which would undoubtedly be assigned to the President by the legislation.

Who should do research and development? Should industry help pay for government R&D if the system is transferred to the private sector? By what mechanism?

Mr. Beggs (NASA) :

The level of continuing government support for long term fundamental research in land remote sensing systems and technology would depend on the priority established in future budget years. However, industry should assume responsibility for conducting research and development (R&D) to improve system operation and profitability and should be able to co-operate with and contribute resources to the government R&D program if operational improvements will result. Several mechanisms already exist for NASA to cooperate with industry, such as: (1) engaging in joint arrangements with U.S. domestic concerns in research programs directed to the development or enhancement of U.S. commercial leadership in processes which utilize the space environment; and (2) conducting research programs having a final objective of enhancing U.S. capability by developing space-related, high risk, or long-leadtime technology; and (3) entering into transactions with U.S. concerns designed to encourage the commercial availability of NASA space flight system products.

Mr. Wright (Commerce) :

To maintain U.S. technological leadership in the remote sensing satellite field, the U.S. Government should continue its space development and testing of new space technology, even after industry assumes responsibility for operational land remote sensing from space. This is essential in an area such as remote sensing where the high risk nature of proof of concept research places it beyond the reach of private sector financial capabilities. In the case of communication satellites, the U.S. Government did not continue R&D activities after the commercialization of civilian satellites. As a result, U.S. leadership in the communications field slipped markedly and NASA was authorized to re-enter this field of research.

Industry should bear the full costs of sensor refinement, satellite design, and those aspects of applications development and testing that are integral to its marketing program. Government efforts in applications should be restricted to providing advanced technology transfer in areas of public concern, and to those developments required to extract information from the satellite data required by governmental needs.

Mr. Rosenberg (General Electric) :

R&D is such an expensive and risky operation that only the Government can do it effectively. Recent experience in communications R&D, in which the private sector was un-

willing or unable to take over R&D from NASA, and thus lost ground in competition with foreign entities, should be instructive in making this determination.

Dr. Charyk (COMSAT):

R&D has been, and should continue to be, a traditional and proper role for the Government. NASA has fulfilled this role, and we would hope that it would continue to participate in this essential area. As is the case now with the NOAA and GOES satellites, NASA could first introduce new sensor and associated data improvement and processing systems on either its own or on an operational systems satellite. Based on the success of this "Proof of Concept" step, these new technologies would continue as part of the operational system.

How should the sale price for government equipment be determined for a transfer to the private sector?

Mr. Wright (Commerce):

The Administration is examining this issue at this time and will have recommendations for the Congress later this fall.

Dr. Halbouty (Michael T. Halbouty, Inc.):

Government equipment should be depreciated. Actually there is little government equipment industry will want because it is experimental and is so out of date. Why is Congress concerned with this? NASA and industry can work out these details—you can't write legislation to cover all the different cases!

Mr. Rosenberg (General Electric):

If the assets were to be priced at or near their real cost or replacement value, the only fair way to make such a transfer, valid precedents exist. The first recourse should be to negotiations under the traditional advocacy system which has always prevailed between Government and the private section. If this fails to produce agreement, the good offices of a knowledgeable and neutral third party could be employed in relevant fact-finding. There are also various formulas, involving replacement value, depreciation, interest rates etc., commonly used in commercial business, which might be agreed upon as a basis for equitable pricing.

Dr. Charyk (COMSAT):

It should be based on estimated "book value," useful life-time, operational system need, and technical currency/obsolescence factors. For instance, new NOAA spacecraft would be purchased from the Government at cost. Existing ground equipment, if acquired, would be purchased based on the factors mentioned.

The sale price for Government equipment to be transferred should be established by negotiation between the executive

branch and the company to which the property is being transferred. A negotiation is desirable because of the high number of variables involved and the relationship between the price of the equipment and the price of data.

If operational remote sensing from space were to go to the private sector, are there advantages or disadvantages of initial government operation of the space segment?

Mr. Wright (Commerce) :

There is no direct effect on continuity of data from initial government operation of the operational land remote sensing system. The only disadvantage—which would be indirect—arises from the question whether land remote sensing operation by the private sector can be accomplished rapidly enough to permit a private system to be in operation by the time the present system consisting of Landsats D and D' ends with the failure of Landsat D'.

Mr. Rosenberg (General Electric) :

Certainly Government retention of responsibility for maintenance of data continuity would be advantageous in any operational system.

Dr. Charyk (COMSAT) :

Developing a remote sensing business is a high risk endeavor made less so if the risk taker has the broadest visibility and greatest control of the total system possible. A hybrid system where the Government controls the data source and private enterprise sells goods and services would be an awkward and, we think, unworkable arrangement that would not promote continuity, user oriented systems designs, or real market development.

With respect to technical development?

Mr. Beggs (NASA) :

Technical development is an area in which continuing government participation would be most appropriate. However, in a commercial operation, the government's efforts would not involve nearer-term or product improvement changes particularly in the ground system, which would be the responsibility of the commercial operator. No particular advantage or disadvantage is perceived from interim government operation, so long as such operation is appropriate to the transfer process.

Mr. Wright (Commerce) :

Initial government operation of the Landsat space segment should represent an advantage to private sector operation in that it permits several years for development of the potentially long lived solid state detector technology required to eliminate the mechanically scanned MSS and TM used on Landsat D. There are no disadvantages to initial oper-

ation by the government, provided industry perceives that the government intends to transfer the system to the private sector and to refrain from competing with industry for the data market.

Mr. Rosenberg (General Electric) :

Technical development in sensors, spacecraft, data systems and applications should be wholly or in part a continuing government responsibility.

With respect to market preparation?

Mr. Rosenberg (General Electric) :

Since the Government is the principal market for data, it would also have important responsibilities in market preparation and aggregation as the initial step in transition to a privately owned space segment. It would be important, however, to have specific agreement on the duration and extent of such Government functions. Without such agreement there would be a tendency for the Government to exert continued control over space segment operation, making it extremely difficult for any private entrepreneur to bring such operation into conference with commercial practice.

Dr. Charyk (COMSAT) :

With respect to market expansion, the private sector has historically been more effective in developing markets for products and services. Thus, initial government operation is an advantage only in that it provides a source of data to existing and potential users of data until the private system can be designed and a marketing effort put in place based on the performance of the private system.

JOINT VENTURES

What would joint ventures between government and business contribute to the present system? Is legislation necessary to permit joint ventures?

Mr. Beggs (NASA) :

The Administration has stated an intent to move operational land remote sensing into the private sector, and there are a number of possible areas of activity that will support that goal. The strengths of the private sector are surely in efficient operation and the development of new markets; those of the government are in space technology and major system design. Decisions on whether joint activities should be started will rest on whether or not the private sector will be able to afford the necessary steps without a government contribution through joint ventures, and the value of the government of having the various remote sensing capabilities continued in a timely manner.

A requirement for authorizing legislation will depend on which agency is involved and what the function of the venture

is. In many areas, NASA is already authorized to engage in joint ventures.

Mr. Wright (Commerce) :

Joint ventures may have the advantage of increasing operator flexibility in system design and funding arrangements. However, it is impossible to state generally whether joint ventures are preferable to other institutional arrangements. Instead, each joint venture must be evaluated for cost savings and benefits to users. The Administration does not now support a joint venture for future systems that would involve commitments of Federal funds.

Legislation is needed to authorize civil operational land remote sensing from space. No Federal agency now has authority to manage or supervise civil operational land remote sensing satellite systems. Authority to enter into joint ventures could be included in this legislation. In the case of meteorological satellites, some forms of joint ventures are legally possible under the existing broad authorities of the Secretary of Commerce to observe environmental conditions and forecast the weather.

Dr. Halbouty (Michael T. Halbouty, Inc.) :

Joint ventures between industry and government are the only way to get industry involved in the near term. Currently NASA has difficulty in consummating joint ventures with industry because by law NASA cannot commit to funding beyond the coming approved fiscal year.

Mr. Rosenberg (General Electric) :

In my opinion, any private sector venture in the present system would be a de facto joint venture in which the Government would share losses, since the existing market cannot enable any entrepreneur to recover his costs, let alone show a profit. Since a joint venture would confer upon the Government ambiguous roles as underwriter, entrepreneur, and customer it is difficult to see what advantage such an arrangement would require.

If such an arrangement would be contemplated, enabling legislation would certainly be necessary. It would be inordinately difficult to draft and enact such legislation, given the difficulty in defining the obligations and entitlements such an arrangement would require.

Dr. Charyk (COMSAT) :

Joint ventures between Government and industry are little used but potentially valuable and beneficial arrangements. We foresee two areas of particular use for joint ventures. Ventures where the Government and industry orbit their own sensors on a shared satellite could be used to reduce the mission costs for both parties. Joint ventures could also be used to successfully bridge the gap between experimentation and commercial application in cooperative type missions. We be-

lieve that NASA has adequate authority to enter into these type arrangements and has implemented a policy to encourage joint endeavors with the private sector.

UNIVERSITY ROLES

How is the contribution of universities important?

Mr. Beggs (NASA):

Through their research and education charter, the universities have conducted joint demonstration projects with user organizations and have provided training to the resource managers of the future. As a result, remote sensing has become another resource management tool that resource managers have learned to use and can call on as appropriate. In addition, universities have conducted basic and applied research in the application of remote sensing to various public and private resource problems.

Mr. Anderson (National Conference of State Legislatures):

The universities and NASA both have important roles in relation to R&D. Both have made significant contributions and should be funded by the Federal Government to continue R&D so as to maintain U.S. technological leadership and prevent a reoccurrence of the communications satellite R&D lapse.

Dr. Simonett (University of California):

The university role in the growth of a new technology such as remote sensing is multi-faceted. At the one extreme there are the large research universities which grant the Ph. D. degree, and in which both basic and applied research on remote sensing technology and applications are carried out. At the other extreme are the small institutions in which a few undergraduate courses employing remote sensing may be given. The latter, which are large in number, serve a broad educative function in allowing a large number of university graduates to at least be aware of the existence of the technology. This is an important part of the general educative process in a high technology society. The former serve a special role in providing the creative and highly skilled technologists, who have grown up with intense and focused disciplinary and inter-disciplinary work in remote sensing within a vigorous research program. These people in many ways are the continuing agents of change. As they graduate and move into private sector and government employment the continuing feedback between the education, funding, and business/applications communities develop. Much of the last eight years, since the launch of Landsat I, has been spent in bringing together the elements of this process. Well-trained graduates of the universities are now reaching middle-level positions within government and are encountering other col-

leagues who have at least heard of the notion of remote sensing. A complex technology such as remote sensing is going to take tens of years to fully permeate and be maximally effective in both government and private sector resource monitoring and assessment. The research and training programs at the Master's and Ph. D. degree level of major universities are absolutely key in this process. As is true of most high technology areas the graduates of such degrees do not have to hunt hard for jobs. Companies are interviewing on campuses for such graduates.

Mr. Rosenberg (General Electric) :

The university community has made substantial contributions at very low cost to both technical and applications research in remote sensing. This is important because only in a university is it possible to train future participants in the system in the cross-disciplinary methods necessary for best use of the system. Universities are also important sources of technology and talent which are readily available to associated state governments which wish to take advantage of land remote sensing, but lack adequate budgets and trained manpower.

Dr. Charyk (COMSAT) :

Universities are a major contributor to applications research in multi-disciplinary areas utilizing remote sensing such as forestry, agriculture, hydrology, and geology. Significant advances in the use of computer aided analysis have come from university research, and several universities have established institutes to specifically focus on research involved with satellite remote sensing. Universities have and, we believe, will continue to make a major contribution to remote sensing advancement.

What should be the role of universities in the future, i.e., if we have an operational system? What should be the role of the Federal Government vis-a-vis universities?

Mr. Beggs (NASA) :

It is important that the universities continue to be involved in research, education and public service during the evolution of an operational system. The universities should continue to provide a source of expertise for research on new remote sensing systems, information extraction techniques, as well as applications. They should also continue to be an important source for public and private user organizations for training and value-added data analysis services. The Federal Government, on the other hand, is in a better position to assess its own information needs which could be satisfied by remote sensing technology and carry out the high risk research and development, and test and evaluation of new technology.

Mr. Rosenberg (General Electric) :

The Federal Government should support land remote sensing R&D in the universities in the same way it supports other basic and applied sciences. A private operator could also fund universities for specific tasks. Adequate precedents exist for support of such activities through both programmatic and disciplinary grants.

The Federal Government, however, should not establish such research objectives directly, but should work through user boards and other impartial bodies in determining objectives and methods.

Dr. Simonett (University of California) :

The role of the university in the future in relation to an operational system could very well be analogous to that with the operational meteorological satellites. Research is being carried out with data derived from operational meteorological satellites. Such research is an integral part of gradually improving the range and efficacy of uses of the operational satellites. The universities are qualified to do such research, and carry it out at less cost than any other sector of the research community, and hence it is a proper investment of Federal research monies in universities to have the training and research elements carried out hand in hand. An even larger element of university research would naturally be concerned with the newer instruments and devices under the process of development, and launched for experimental testing. It is always a question of balance. Some systems, even when operational may generate a large number of useful research ideas. Universities will be sufficiently entrepreneurial to find these and to convince funding agencies that they are of sufficient merit to be funded! No specific Federal government intervention or subsidy would be required for universities to do what comes naturally to them. However, there is a concern that remote sensing research and development within the universities not be allowed to wither with reduced Federal funding. The pattern of research and development in microtechnology in the U.S. provides a warning in regard to remote sensing: the universities lag seriously in both R&D and education microtechnology; the action is overwhelmingly in the private sector, with all kinds of serious consequences for research and education. It is important that research be federally funded, and that the National Science Foundation enter more vigorously into both areas. Cooperative government/industry/university research will be beneficial in helping to maintain the U.S. lead in R&D in remote sensing. The Japanese and West Europeans have moved very rapidly in the last two or three years. Cooperative university research under both federal and private funding will ensure that universities will remain at the leading edge in both research and teaching. Research and development must continue into the indefinite future under both federal and private sponsorship. Both components are essential for healthy growth in

basic applied engineering, applications, and development areas, as well as in basic research.

Dr. Charyk (COMSAT) :

The role of universities during the period of an operational system will likely continue to be, in large part, to contribute to applications research. It is in this area that Government support to universities could be shared with industry and, specifically, joint endeavors or joint ventures could be established to focus on specific applications research with funding provided through sources other than federal programs. As in any case, the Federal Government should continue to support universities in fundamental research programs (i.e., Principal Investigators) that have proven so successful in the past for advanced sensor systems. This is consistent with NASA maintaining a strong leadership role in advancing sensor technologies that have ultimate use in an operational system.

How would commercialization affect the universities? What are the dangers or benefits of commercialization for universities?

Mr. Beggs (NASA) :

Overall, commercialization is likely to have a number of key benefits for universities. It will increase the demand for trained personnel in user organizations and value-added firms and will greatly increase the use of remote sensing data on a routine basis. The universities will receive the benefits of this routine use through increased need for research as well as routine data analysis service for users. The danger for university programs is that without guaranteed support they will be subject to the uncertainties of the competitive selection process. The competitive selection process could result in reductions of Federal funding support for some university centers, but the best centers are expected to continue.

Mr. Wright (Commerce) :

With commercialization, remote sensing data will become more expensive, and universities will need additional funds to meet these expenses. Some new applications techniques or other advances made by the private sector may not be as readily shared with university experts. On the other hand, a growing remote sensing industry would provide more work for graduates of university remote sensing programs. In addition, industry might become convinced that steady support to universities in the field of remote sensing, is in its best interest, as has happened in the computer science field.

Mr. Rosenberg (General Electric) :

There is also a danger that an entrepreneur would regard universities as very poor prospects for profitable marketing, and thus would neglect their needs. It is difficult to conceive of any benefits which universities would derive from commercialization of land remote sensing.

Dr. Simonett (University of California) :

Commercialization per se is neither especially beneficial or disadvantageous to universities. I see it as essentially neutral. However, some of the consequences that could flow from decisions associated with, but not necessarily a necessary ingredient, of commercialization could have a severe impact on the universities. I refer specifically to the question of pricing policy. I am strongly prejudiced in favor of a continued federal subsidy for a further period of at least five, and preferably ten, years of provision of low-cost data to universities. A rapid increase in costs of the raw data will reduce the amount of research being done if the total research dollars remain constant. From about 5 to 8 percent of total present research costs, the raw data costs would move to approximately 30 percent. With a relatively modest research budget available for remote sensing in the universities this is a serious matter. There are various ways in which such a subsidy could be handled. A separate fund could be set up that would enable federally funded research projects at universities to obtain a direct subsidy from the fund, and still pay general commercial rates.

Dr. Charyk (COMSAT) :

It is our belief that ultimately universities will greatly benefit by commercialization and expanded applications research since the marketplace will inevitably demand more specific software and analytical techniques that can be obtained from university research alone. The dangers to universities are, in large measure, related to the unknowns associated with commercialization. Programs in the past that have been deeply entrenched in the Government and by-products which have been made freely available to the universities engender an expectation of a continuity of products at little or no cost. Universities can well anticipate paying more for data obtained from a commercial operator but, at the same time, can expect improved services associated with deliveries of such products and services.

PUBLIC SERVICE

How is the utilization of remote sensing data important to the public welfare and health?

Mr. Beggs (NASA) :

A number of Federal agencies, such as Corps of Engineers and the Bureau of Land Management, make extensive use of Landsat data for public service functions. The states have been especially articulate in stating their views, often in direct testimony. Our understanding is that remotely sensed data is viewed by the states as important to the public welfare and health because it yields information needed to improve management decisions in economic development and planning, environmental management, and maintaining the quality of life.

Resource inventories (e.g., forests, minerals, surface water, prime agricultural land) provide a sound, objective basis for economic development and planning by delineating what is available for use, how resources are being maintained, and how renewable resources (such as forests) are being managed. The data are used not only in finding resources but in making tradeoffs between alternative uses of resources to guide development such as urban expansion.

To successfully execute these responsibilities at the lowest cost, state and local governments may want increasingly large and diversified quantities of data on a recurring basis. In all of those areas related to the public welfare and health, satellite data hold the promise of helping the states make more informed decisions and regularly monitoring the impact of those decisions. The unanswered question is whether the benefits returned to state and local governments will justify expenditures sufficient to cover the market costs of satellite remote sensing data.

Mr. Wright (Commerce) :

Public agencies at all levels of government are concerned with accomplishing their mandates cost-effectively. Agencies that have used remote sensing data have had management responsibilities for natural resources and the environment, such as developing water resources, overseeing petroleum extraction and mining, maintaining transportation networks, managing air and water quality, and executing emergency preparedness procedures.

Remote sensing data allow experienced observers to assess conditions more rapidly, and at less cost per unit area, than conducting surveys on the ground. Aerial photography is used where surface detail is required and/or small areas are being inventoried. The value of Landsat and future land remote sensing satellites to public services is that very large areas can be observed with a consistent data format on a regular schedule and at less cost than with other methods of inventory and assessment.

Mr. Rado (National Governors Association) :

Concern over deteriorating and/or diminishing resource supply has led to the development of policies and management strategies aimed at preserving the economic and ecological productivity of the resource base. Public agencies, as stewards of the natural environment have the difficult job of establishing balanced resource policies and programs in an arena characterized by conflict. Resource policy decisions have reaching implications for public health and safety. They also have a major effect on the economy. Timing and accuracy of information is critical to sound resource decision making. Landsat provides one tool for addressing resource issues in a timely, reliable manner.

Mr. Rosenberg (General Electric) :

In the largest sense, the mission of land remote sensing is efficient management of renewable and non-renewable re-

sources and preservation of a healthy environment. Although these objectives impinge on private interests, they are nearly all macro-missions whose benefits can be aggregated and distributed only by Government. Thus by its synoptic scale of operation, remote sensing must necessarily be an instrument of public policy.

Dr. Charyk (COMSAT) :

Today, meteorological satellite remote sensing is the most mature source of data contributing to the public welfare and safety. The relatively mature utilization of these data is principally due to two factors: (1) the decisions taken in the 1960's and early-1970's to make these systems operational; and (2) the resulting emphasis on establishing products, services, and delivery networks directed to end-users, as well as the scientific community. As a result, data from GOES and TIROS are used to:

- Identify the location of actual or potential severe weather conditions;

- Monitor the direction, speed, and changes in potential severe weather patterns;

- Provide public information on weather conditions several times per day;

- Map snow and ice conditions for use in navigation and prediction of hydrologic conditions;

- Provide direct read out foreign access to satellite weather data; and

- Relay locally sampled environmental data from remote locations to central processing.

These data are then used, primarily by Government agencies, to issue advisories and warnings, to predict areas of potential storm impact, to advise mariners to prepare for excess or limited water storage conditions, and to measure local events through data relay against the synoptic conditions reported by satellite. There also appears to be a growing demand for the commercial use of these data for public information and tailored interpretation.

Landsat data has lagged behind meteorological information in its contribution to public welfare and health. However, limited use of Landsat has been made to determine and verify snow pack for water management, to assess the nature and extent of flood or other catastrophic damages, to monitor forest and crop diseases, and to measure the concentration and movement of pollutants. Other uses that await full exploitation include such activities as monitoring decertification, improved forecasting of global food production, use of data derived from these activities for population and development statistics/predictions, and regional environmental baseline-impact assessments. Higher resolution, better absolute positioning, and other advances that can be implemented relatively quickly on an operational basis would expand these benefits substantially.

Perhaps the most exciting potentials for increased public and commercial benefits in the future lie in the combination of these systems and data products into a unified operational system of environmental information and services. One key to increased benefits is the application of additional resources to the delivery sub-systems; the key to obtaining these resources is the balanced involvement of and contributions made by commercial users.

To what extent are state and local government utilizing this data for public services?

Mr. Beggs (NASA) :

Current state government uses of satellite data for public services were summarized in a May 1981 report by the staffs of the National Conference of State Legislatures and the National Governors Association. Based on a survey of lead resource agencies in each state, the report lists 594 applications of Landsat data; a growth of 61 percent from the 371 applications surveyed 3 years earlier in 1978. In addition, 15 states are identified as having routine operational capabilities to use Landsat data.

Mr. Anderson (National Conference of State Legislatures) :

The states have been in the forefront in developing applications Landsat data. By July 1978, four states had developed operational capabilities to analyze and apply Landsat data. It was not until the initiation of the NASA Regional Applications Program, however, that most states had the opportunity to evaluate Landsat technology. Following cooperative state/NASA demonstration projects, about 22 additional states developed or are in the process of developing operational Landsat capabilities. To date, 26 states and 15 local or regional entities use, or are developing capabilities to use, Landsat data.

A total of 594 Landsat applications in the states have been documented. Of these, 241 are considered to be operational, and 40 to be routine/continuous. In addition, 131 potential future applications not yet attempted in particular states have been identified.

The states have made major investments in Landsat since the first satellite in 1972, including:

- Almost \$28 million in total expenditures of state-controlled funds (\$10.8 million from state general funds, and \$15.6 million in state-controlled federal funds);

- Training for over 3,300 state personnel;

- Over 760 person years of staff time;

- Various institutional arrangements to facilitate the use of Landsat data;

- Over \$5 million in expenditures for computer hardware and software; and

- Nearly 20,000 Landsat images ("photos") and 2,700 computer tapes (purchased by states directly, or by others on behalf of the states).

What are the primary concerns of the state governments (1) with the system as it would be if Landsat-D (and D') were run by NOAA as they are now running Landsat-2 and -3? and with the future commercialization of land remote sensing?

Mr. Rado (National Governors Association):

It is not important who runs the systems as long as it exists.

Mr. Anderson (National Conference of State Legislatures):

The primary concerns of the states for the system proposed by NOAA in the transition plan have been outlined in detail in previous testimony before the Congress. Briefly stated, our major concerns are for data continuity, the continuation of the NASA Landsat Technology Transfer Program, and for state representation in Federal Landsat decision making.

Our concerns for a commercial system are similar, with one additional major point. Private sector attention could be focused on the requirements of major users only, with state concerns given short shrift. The states are relatively small users when considered in the perspective of the entire potential Landsat market, probably less than 10%. The public policy significance of their usage, however, is much larger than the gross dollar volumes of state purchases. With increasing responsibilities thrust upon the states and increasing demands for their limited resources, the states should be considered important users out of proportion to their "market share" and should have a major voice in Landsat decision-making, whoever runs the system. It would be a terrible waste if our states were not allowed to benefit from the \$1 billion investment in Landsat technology to the fullest extent possible.

Mr. Beggs (NASA):

The concerns of state and local government regarding operation of the Landsat system were most explicitly stated a year ago in recommendations by the National Conference of State Legislatures and the National Governors Association. These concerns were: Data continuity; frequency of observation; availability of technology transfer; participation in decision-making regarding the system; capabilities of the operational system; improvements to the data processing systems; drastic increases in data prices; copyright restrictions; and maintenance of archiving.

CENTRALIZED VERSUS DISTRIBUTED SYSTEMS

Is present data receipt and handling centralized? What are the advantages and disadvantages?

Mr. Beggs (NASA):

In consideration of centralized versus distributed data receipt and handling, the most important factors to the user community are reliable and timely receipt of the data, con-

sistent quality, and low-cost data products. With the exception of the Landsat foreign receiving stations, the present data receipt and data handling system is centralized. The advantage of a centralized system is that it produced products of similar quality in a standardized format and assures compatibility of data on a nationwide basis. The predominant disadvantages are: (1) possibility of system backlog of data due to the large volumes and single throughput points; (2) vulnerability to single point failures due to hardware or software failures, or even labor problems; (3) a single geographical location which hinders user access for data searches and communication.

Mr. Wright (Commerce) :

Both the present Landsat 2 and 3 system and the new Landsat D system are a combination of centralized and decentralized data receipt and handling. All data destined for the U.S. archive and users obtaining data through the EROS Data Center (EDC) arrive at Goddard Space Flight Center and are preprocessed on a single system (part of which is at EDC). On the other hand, ten foreign ground stations now receive and process regional data received by direct broadcast from Landsat. No foreign ground station is currently equipped to receive Thematic Mapper data from Landsat D but several are planning to modify their stations to do so.

The advantage of this mix is that the United States can obtain data from any part of the world (through the use of tape recorders on Landsats 1, 2, and 3 and via TDRSS for Landsat D and D') while foreign users served by foreign ground stations have local access to data from a nearby source. The chief disadvantage is that cost recovery is complicated for data received by foreign ground stations. NOAA is currently studying pricing schemes which can overcome this disadvantage.

Mr. Rosenberg (General Electric) :

Data receipt and correction are centralized at the NASA Goddard Space Flight Center. Their handling, archiving and distribution are centralized at the Earth Resource Observation Service in Sioux Falls, South Dakota.

The advantages of such centralization are obvious: economies of scale, concentration of resources such as skilled manpower, and the ability to manage technology development on a system basis so as to benefit the entire community of users. The major disadvantage of the present system is the division of responsibility and duplication of facilities between Goddard and EROS. There is a growing feeling that these services should be consolidated, both administratively and geographically. Since data can be moved rapidly to any point on earth via satellite, there would appear to be no disadvantage to centralization.

Dr. Charyk (COMSAT) :

Current systems cannot achieve a market balanced centralized versus distributed system design because many of the decisions governing these choices are determined by several operating institutions. Thus, present systems are necessarily inefficient and higher priced because there are multiple satellite control centers, data acquisition networks, processing, distribution and archival systems. Research and development goals may be best served by such an arrangement, but cost effective operational aims are not possible with this approach.

Comsat has acknowledged strengths in data management and distribution, and we believe that a successful system will have both centralized and distributed data systems determined not by legislation but by market development and operational economics.

The centralized part of the system should be based on economic and system efficiency factors, and our proposed consolidation of control centers, data acquisition stations, and standard product processing and distribution systems reflects this approach. Value added services will be provided by highly specialized and widely scattered industries and, as such, will form a necessarily distributed data handling and user oriented service organization.

Could a new system (i.e., new satellites, etc.) be designed for distributed data receipt and handling? If this is possible, what are the possible benefits and disadvantages?

Mr. Beggs (NASA) :

Taken in the large, the present system is already one designed to take data from a single satellite, pass it through several transformations of data analysis and interpretation, and ultimately deliver it to literally thousands of users who usually combine the Landsat data with the data from other sources in the final step of generating information. The system design question is then one of deciding at what point in the cascade one changes from centralized to distributed. Obviously having multiple channels of distribution adds redundancy to the total system, but at some additional cost and some problem with how much additional traffic the remaining channels can handle should one of the regular channels fail. The channels can develop specialty characteristics ranging from particular geographic coverage to a concentration on special data products tailored to particular groups of users. Generally, a more fully distributed system will be able to cater to user interests more easily, but cost, management complexity, and ability to query the entire data base will be increasingly difficult.

Mr. Wright (Commerce) :

Fully distributed data receipt and handling would require an augmented network of ground stations throughout the entire world since current ground stations do not permit data recovery over a large portion of the earth's land surface. Furthermore, processing of the data from such sophisticated sensors as the Thematic Mapper requires expensive computer systems which would have to be duplicated throughout the world for fully decentralized data handling. The cost disadvantages of a fully distributed system offsets the advantage of local access. An additional disadvantage of decentralized data handling would be the difficulty of providing uniform products from all data processing systems.

The early months of Landsat D operation will involve a quasi-decentralized mode of operation whereby tape recorders will be installed in approximately five foreign ground stations to acquire MSS data only from Landsat D until the TDRSS achieves operational status. The disadvantages of this mode of operation are that many areas of the world will not be accessible through foreign ground stations so that MSS data on these areas will not be available. In addition, MSS data availability in the United States will be delayed for about two weeks to allow shipment of tapes to the United States.

Mr. Rosenberg (General Electric) :

Such systems have been postulated on the theory that data gathering, processing, and distribution could more efficiently be handled by discipline, i.e., geology, agriculture, hydrology, etc., or from geographically dispersed centers. However, the obvious advantages of centralization and the availability of efficient means for rapid distribution through satellite networks seem to outweigh by far the advantages of decentralization of any system elements.

Dr. Charyk (COMSAT) :

A new system will evolve, after commercialization, that will achieve a balance between centralized and distributed data receipt and handling based on market development responses. The benefits of such a balanced system are reduced costs for system operations, more efficient and user responsive data collection and distribution networks, and better data products leading to increased sales as a result of a natural market development. The Government will continue to be a major customer and will continue to influence market evolution through this and the Government R&D development activities already discussed. With proper Government controls and continued participation, there are few, if any, disadvantages associated with this natural approach to system improvement.

DATA PRICING

For a government-operated system, should there be a pricing structure. For example, should the price of data be time dependent? Should different spectral bands be priced differently? Should various users pay different prices? By what process should a price structure be determined?

Mr. Beggs (NASA) :

For a government operated system, there should be a pricing structure other than the marginal cost of reproducing the data products. Prices for various types of products can depend on quality, amount of information, timeliness, required special processing, and so forth, with the goal of total revenue being recovery of system operating costs. The price for each class of product should be the same for all users, although quantity discounts for large orders of a particular product could be considered.

Mr. Wright (Commerce) :

The Department has developed a pricing proposal for products and services from the Landsat D system that is now under Administration review. The proposal is designed to recoup the costs of operating and maintaining the system, starting in fiscal year 1983. No decision has been made on amortizing sunken costs for hardware or development.

Mr. Rado (National Governors Association) :

A pricing structure should be established that is understandable, so that public users can project prices for inclusion in their budgets. There are a number of seemingly reasonable variations for pricing. The states would like to examine the alternatives and participate in the determination process.

Mr. Anderson (National Conference of State Legislatures) :

The current uniform pricing structure is satisfactory. Standard products all have standard prices, regardless of when the data were acquired. Users who wish to have priority processing on their orders pay three times the normal price regardless of when the data were acquired. Perhaps consideration should be given to reducing this surcharge when the standard prices are increased, but the principal is still valid.

Different spectral bands should not be priced differently. Uniform prices for all users would appear to be desirable, although the states would certainly not be adverse to any subsidies to reduce the costs of data directly or indirectly for state and local governments.

The overall price structure should be determined by the results of market studies, recognizing the need for the system to recover on ever increasing portion of costs, and allowing users time to adjust to increases over time. We should, at all costs, avoid what I will term the "mass transit spiral"

where increasing fares cause decreasing ridership resulting in a net reduction of revenues. We should not attempt to suddenly get current users to pay the full system costs, but should aggressively attempt to broaden the market so as to increase the size of the base over which costs are spread. Price increases should be small, phased and announced several years in advance so as to promote rather than discourage increased usage.

Mr. Rosenberg (General Electric) :

There are only two logical ways to manage the pricing of data.

(1) The cost-based method. The system operator should be able to establish exactly how much each product and service costs him and to pass this price on to the user with the necessary adders for profit, depreciation, interest rate, overhead, etc., according to standard business practice. This method requires no arbitrary judgements by the system operator, and can best be defended on the basis of equitability and consistency with existing laws and commercial practices.

(2) The benefit-based method. Under such a system, the system operator would assign a price to each product and service which would be based on the benefit conferred upon each user, regardless of what it cost the operator to produce it. This is a classic pricing policy of a theoretical monopoly, and is typified today by the pricing mechanism used by the OPEC nations. Such a system would necessarily involve arbitrary judgements as to what the benefits are worth to a user. It would be extremely vulnerable to competitive systems, particularly foreign systems supported by their governments.

Dr. Charyk (COMSAT) :

Price structures for Government operated systems data products exist today. The structures generally are designed to cover the costs of reproducing data delivered to users. Most observers agree, however, that even this objective is not being achieved. In some cases, the structures are designed to offer popular products at virtually no cost (e.g., Landsat standard photo reproductions). In other cases, such as the direct read-out of imagery, there may be no costs associated with receipt (as with GOES and NOAA) or the costs are not associated with the quantity or potential value of products to the recipient (as in the Landsat foreign receive station agreements). None of the Government operated price structures attempt to recover the full costs of end-to-end system investment and operation.

Prices should reflect the value of delivering data that is time-perishable as well as the costs associated with the improvements needed in delivery sub-systems. Even though users often complain of delays or uncertainties in data delivery from current systems, pricing incentives or premiums have not been established to overcome this problem. There

simply has not been a "market environment" to provide incentives to either provider or recipient to change system capabilities to meet demand signals. Instead, standard, heavily subsidized, and stable prices often are perceived by users as "rights" and improved services at the same prices as "obligations".

Pricing structures must undergo a thorough review rather than the marginal changes in prices suggested by charging different prices for different spectral bands. One key to a revised price structure is to develop products that are attractive to commercial, as well as, public users. Operational systems and services should be designed to achieve the highest value for the least investment. Various users should pay different prices for variations in product packages and service delivery. To the extent consistent with overriding public benefits, prices should be matched to value of service, prior commitments to buy, quantity of products purchased, and other market associated criteria. Provision should be made, if necessary, to underwrite explicit product and service prices that are necessary to achieve defined public benefits.

We believe a pricing structure should be built upon a consolidation of satellite systems and services, a declining proportion of governmental purchase commitments of system products over time, and variable pricing based upon such factors as the maturity of market demand, revision of direct receive arrangements, commercial use of data collection systems, and bonafide market promotion.

Dr. Simonett (University of California) :

Probably for some time there should be a differential pricing structure, because not all users have the same relative entry costs to the new technology. Deacon, Simonett and Smith (1978) define a pyramid of users at the top of which lie a small group of large commercial corporations, some federal government departments, and some large research universities operating under federal funding. At the base of the pyramid, in much larger numbers, lie state governments, county governments, the less developed countries, and small teaching institutions. The ability to pay is correspondingly stratified and a differential pricing policy is necessary in order to allow those at the base of the pyramid to both enter and remain as users of remote sensing data. There is no doubt that for some users the present pricing structure, with its significant subsidy, is required for entry into the new technology. Even for the most sophisticated and demanding users it is clear that the present pricing structure was, indeed, necessary some years ago. The subsidy has been necessary even for these groups. Deacon, Simonett and Smith argue that the prices which could be borne by the public sector could be determined through use of demand-revealing structure techniques currently being experimented with by economists. To my knowledge no such analysis has yet been performed by

NASA or any other federal agency. In addition to a differential pricing structure based upon ability to pay, the price should also be time-dependent. Data needed urgently and supplied promptly should carry a premium price. There is no intrinsic reason why different spectral bands should not be priced differently, though it would seem to be an unnecessary complication. Rather it seems more reasonable to anticipate that the output of different instruments might be differentially priced. The processes of determining a price structure should include the use of Demand-Revealing Processes and Cost Benefit Analysis. I am strongly prejudiced in favor of continued federal subsidy for a further period of at least five years in order to nurture this new technology. The division of the subsidy between space development, space and ground operations, and reproduction costs, should be subject to regulation, review, whether the system is private sector or government operated, at probably five-year intervals. Subsidies should be acknowledged as such and could be differentially applied to the different parties. As noted repeatedly above, those receiving the highest subsidies could include developing countries, universities, and state and county governments, based on an ability-to-pay criterion, and to deliberately stimulate further research development and applications in these sectors. The transfer payments so arrived at could be directly treated as being attributable respectively to foreign aid, basic and applied research, and state and county revenue-sharing.

If the government is going to run a system, should it recover costs? In the future? What about amortizing sunk costs for hardware or development?

Mr. Beggs (NASA):

Any consideration of recovery of sunk costs needs to take into account the fact that prior expenditures were not justified for the creation of an operational system, but primarily for research and development purposes.

Dr. Halbouty (Michael T. Halbouty, Inc.):

The government should recover its costs for reproduction of experimental data and all users should be charged equally. Recovered costs should not include any costs for the experimental system, equipment required to reproduce the data, etc. Reproduction costs should be related directly to time and material. There is no need for the government to provide any "value-added" special processing services. The government should only reproduce duplicates of master archival film and CCTs.

Mr. Anderson (National Conference of State Legislatures):

If the system is to be government run, operational, maintenance, data processing and data distribution costs should be recovered starting no earlier than January 1, 1985. This will

allow states with biennial budgets to adjust to the increases rather than proportionately reducing the amount of data purchased with a fixed budget.

There should be no attempt to amortize hardware costs till at least the end of the decade to avoid the "mass transit spiral". Research and development costs should be supported by the Federal Government through the end of the century.

Mr. Rosenberg (General Electric) :

There is a sharp division of opinion on the question of whether the Government should recover either capital or operating costs of a land remote sensing system. Well-informed observers note that the Department of Agriculture conducts enormous research and technology transfer programs at no direct cost to its beneficiaries, as do the U.S. Geologic Service, the Corps of Engineers, the Bureau of Standards, the Public Health Services, and many other Government-supported enterprises in the development and transfer of technology. Since remote sensing data users are by and large Government units themselves, it is difficult to establish a rationale for singling out land remote sensing as the one area of Government-sponsored technology which is under obligation to recover its development or operating costs. If this requirement were to be applied to other Government sponsored R&D and technology transfer operations, the technical infrastructure of the nation would suffer. Consistency and logic therefore would seem to be on the side of those who believe that Government should not be required to recover its costs in land remote sensing.

Dr. Charyk (COMSAT) :

If the Government is going to own and operate satellite systems, it should recover the full costs of operational systems. It seems clear that full cost recovery will require changes in pricing policy, price rises for all users, and major market development, product planning, and sales efforts. Research and development costs should not initially be recovered by product and service sales. In the future, however, it appears clear that the cost of applied research, oriented to commercial utilization, must be recovered.

Dr. Simonett (University of California) :

I believe it is essential that the government should recover a larger share of costs, than it has with the present, essentially experimental, systems. A move to a significantly larger component of cost recovery under prodding by OMB, is premature. The diffuse, but growing market needs a longer period of deliberate subsidy and a sudden escalation of costs could turn off the technology. The subsidy, however, must clearly be phased out over time, or if retained for some users, be severely restricted. Sunk costs for hardware and development should normally not be amortised since they are essentially research and development of the sort that the Fed-

eral Government must maintain in order to stimulate new technologies. However, once a basic operational design has been frozen and multiple satellite hardware is available, the operational system should be fully amortised if possible. However, it would be premature to apply full cost recovery in one fell swoop. The appropriate procedure would appear to be to step up cost recovery of the ground operations, then next the space operations, and finally the amortization of hardware.

For a private system, should the government prescribe any guidelines or promulgate regulations concerning data prices?

Mr. Beggs (NASA) :

For a private system, data product prices should be determined in the open market, and not be government prescribed.

Dr. Halbouty (Michael T. Halbouty, Inc.) :

The government should definitely not prescribe guidelines or promulgate any regulations concerning pricing of data produced by industry.

Mr. Rosenberg (General Electric) :

Since approximately half of the market of any private system operator would be the Federal Government, pricing agreements and guidelines which would apply to all Federal Government users would necessarily become part of the marketing mechanism. In addition, if discriminatory pricing policies were contemplated by the private system operator, they would have to be supported by federal legislation, which would inevitably be necessary to clarify and apply them. It is tempting to believe that a private system could be operated under pricing policies determined strictly by the classic market processes, but when the operation, and indeed the survival of the system, depends upon the Government as the major part of the marketplace, significant influence on pricing policy by Government and the promulgation of the resultant regulations would be inevitable.

Dr. Simonett (University of California) :

I do not see how the government can avoid prescribing guidelines at the very minimum, and believe it is more likely that they will need to promulgate regulations concerning data prices. I see no way around hard bargaining coupled with flexibility on a wide range of issues including cost sharing, rights to a federal share of profits, insurance against hardware losses, and development and launch of proprietary instruments or placement in orbit via space shuttle. Pricing structures are just one part of a very complex whole which will need to be bargained about.

Dr. Charyk (COMSAT) :

Since the Government will be a major market segment of near term private system initiatives, it should have a major

role in establishing prices for Government products and services. These pricing arrangements need not be established by rulemaking, but should result from contract negotiations. For products and services that meet other than Government needs, we would anticipate negotiation of the principles governing the terms and conditions of product offerings.

POLICY

Do you feel the potential value and importance of remote sensing from space has been properly recognized and articulated by the previous or current Administration?

Mr. Beggs (NASA) :

Recognition of the importance of remote sensing from space has been clearly demonstrated by this Administration and several past Administrations by the substantial investment to date in the Landsat program. Articulation of its importance was clearly provided in commitment to establishment of an operational system; again, this was initiated by the past Administration and confirmed by the current Administration. Reinforcement of this commitment at a more detailed level is being made by the constituent agencies of the Federal government in terms of their individual interests and progress toward increased use and acceptance of remote sensing. Significant civil uses of satellite remote sensing are either in place or under development in a number of Federal agencies including the Department of Interior, Department of Agriculture, and the Corps of Engineers.

Mr. Wright (Commerce) :

The Federal government has provided over a decade of development, demonstration and operation of land remote sensing from space. This substantial investment has generated sufficient information to allow prospective private sector investors to evaluate whether land remote sensing is commercially valuable.

Mr. Rado (National Governors Association) :

The future of a United States Civil Operational Remote Sensing system is in grave jeopardy. This is due to the fact that there has been no consideration by the current administration of the policy implications of Landsat. The program has been lost on the shuttle to balance the budget. There is no current policy independent of the budget process. It is critical that some leadership be demonstrated to assure proper consideration of a U.S. space remote sensing policy.

Mr. Anderson (National Conference of State Legislatures) :

The potential value and importance of land remote sensing from space were clearly recognized by the previous administration and reflected in PD-54 and the original fiscal year 1982 budget. It would seem that the current administration

has not fully recognized this value, although I'm sure that the argument could be made that, given the magnitude of recent budget cuts, the system would not have survived at all were its importance and value not recognized.

Dr. Halbouty (Michael T. Halbouty, Inc.) :

The potential value and importance of remote sensing from space have been largely ignored by previous Administrations and decisions related to our civil land remote sensing policy have suffered from unwise budgetary control and executive branch inaction which have focused on saving money without due regard to the national interest. Under the circumstances, NASA and the Department of Interior have done an outstanding job in trying to develop a national remote sensing program and the problem does not rest with them. The problem rests with the executive office, specifically with OMB, which without presidential direction, has discouraged the full development of civil land remote sensing, to the point that foreign countries are now developing most of the new technology in this decade. By and large, Congress has been supportive of the domestic remote sensing program, but the program needs legislative mandate to move forward now.

Mr. Rosenberg (General Electric) :

In two decades the United States has spent about ten billion dollars and launched more than 50 spacecraft dedicated to remote sensing of the earth. More than 40 countries regularly purchase data provided by the U.S. Landsat satellites, and 120 can receive weather data from space collected by U.S. satellites. Ten countries are able, or soon will be able, to receive data from land observation satellites by use of their own ground stations.

It is my impression that both previous and present administrations have approved this level of activity by making specific provisions to sustain it. By providing for transition beyond the present experimental phase, the two administrations have recognized the potential value and importance of land remote sensing, supporting continued dissemination and use of the data, and providing for future development of the system to the late 1980's.

Dr. Charyk (COMSAT) :

At present, the necessary emphasis on and investment in remote sensing does not exist and advantages once held by the United States are being lost to other nations. Our position is exemplified by foreign exploitation of technologies developed by the U.S. (i.e., the French SPOT Program), the possible demise of the LANDSAT program, and a reduction in remote sensor missions and R&D. Government space program planning based on a comprehensive goal oriented plan with the kind of continuity required to implement such a plan has been absent from administrative policies since the Apollo experience.

Dr. Simonett (University of California):

I think both administrations have been slow to seize substantial initiatives but I would not go so far as to argue that they have thrown away major opportunities to other countries—yet. However, I think the time is rapidly approaching when the United States must take the initiative if we, rather than other nations, are to reap our fair share of the benefits from space. In his foreword to the National Academy of Sciences publication, "Resource Sensing from Space: Prospects for Developing Countries" (National Academy of Sciences, Washington, D.C. 1977) Harland Cleveland makes the following points:

"Other nations will remain reluctant to harness themselves to remote sensing technology as long as the United States has not given formal assurance of the system's continuity. Since the technology is still in an experimental phase and may take some years to become fully operational, the world is waiting for some clear indication from the United States that the system is to be a permanent part of the government's business. The Congress could clear up the ambiguity when it considers legislation to assign the system as a permanent function to some established, or specially created, agency of government."

(Parenthetically, I would add that in my view a private corporation operating under clear guidelines and regulations promulgated by the federal government, would be as satisfactory as a federal agency. D. S. Simonett).

Cleveland continues:

"Thus far the United States alone has financed the R&D and operation of the space segment of the system. But once it is clearly a permanent part of the international picture, some financial contributions could probably be secured in return for a real voice in decisions about management and about follow-on technologies."

(Cleveland is arguing for an international system. Private U.S. corporation operation of U.S. satellites is, in my judgment, no barrier to internationalizing such systems. The Comsat experience in international space communications, while not a complete analogy, is appropriate).

"Remote sensing technology is still in its infancy, and some important decisions yet to be taken need to be carefully considered to make sure they fit into a phased approach to internationalizing the system."

Cleveland continues:

"It is important to make the following decisions soon:

"A public commitment now to the eventual establishment of an international regime. The United States should begin forthwith to develop its own proposal for such a regime, and conduct our own remote sensing affairs meanwhile so that they are compatible with later internationalization."

(To allay the fears and suspicions of other countries, particularly the developing world, some form of internationalization, even in the context of private corporation operation of the system appears necessary. That such can be managed has been proven already in the Comsat experience.)

"A move (requiring Congressional action) to ensure continuity of coverage and transmission to users of remote sensing data. A U.S. declaration of intent to proceed with further development of the technology would reinforce the presumption that remote sensing of earth resources is here to stay."

(This comment was made four years ago. That these hearings are needed now and that no decision has been made either the present or immediately preceding administration in this area indicates a real need for presidential-level decision).

How well has government policy set the stage for an operational system? What do you feel have been the premier policy decisions (both positive and negative) pertaining to the evolution toward an operational system?

Mr. Beggs (NASA) :

Government policy can deal with the creation of operational systems to carry out existing functions, but it is more difficult to deal with creating systems to carry out functions that have hitherto been unknown, and are thus in some sense unproved until a system has been in operation. Even so, the government policies have included a number of very positive features: support for a series of research and development satellites, the output of which could be used to support preliminary operational tests; supporting worldwide availability and use of the data, thus creating the awareness that the new capability was valuable; the allocation of Federal funds to work with various user communities to develop new applications; provision for satisfying present users of MSS data by adding a MSS sensor to the Landsat-D design.

Mr. Wright (Commerce) :

The first major policy decision was to move from an experimental land remote sensing system to an operational system based on the Landsat D satellites. As a result of that decision, the MSS ground system was re-baselined to provide 85% reliability of data averaged over 10 days. Thus, the Landsat D system has both an operational sensor, the MSS, and an operational MSS ground system. Decisions with respect to the operational status of the Thematic Mapper will be made by 1985.

The second major decision was to transfer responsibility for land remote sensing to the private sector as soon as possible. The implementation of that decision is now being considered by the Administration and recommendations will be made to the Congress later this fall.

Mr. Rado (National Governor's Association) :

Government policy through its research and development programs has made an operational system feasible. However, it appears that the Government may be abandoning the effort just at the time when the system could become actualized.

Mr. Anderson (National Conference of State Legislatures) :

Government policy has failed to set the stage for an operational system by continually delaying the policy decision to go operational. Many users have been discouraged from investing in computers, staff and data by the lack of Federal commitment and the experimental status of the system. A policy decision to eventually go operational five or more years ago would have today resulted in much more operational usage of the data and a much larger market across which to spread costs. Instead, we have been in a "chicken and egg" situation where potential users hesitate to become involved because of uncertain data continuity, while several administrations have hesitated to go operational due to limited user commitments and investments.

In the twilight of the last administration this problem finally seemed to have been resolved. Now, however, we find ourselves back on square one making the same arguments and aiming for the same results we wanted four or five years ago.

PD-54, the Transition Plan and the original fiscal year 1982 NOAA and NASA budgets have been the most important policy decisions relating to the evolution toward an operational system. The recent cuts in the NOAA and NASA budgets, and the reluctance of the previous two administrations to commit to an operational system at some future time have been the most negative.

Mr. Rosenberg (General Electric) :

Present Government policy on land remote sensing was set during an era which gave cost reduction in Government operations the highest priority. Requirements for support of remote sensing were balanced against the demands of the larger fiscal objectives. The near-term result has been an attempt to accelerate system evolution to operational status in a manner which will achieve two main objectives:

- i. Foster the development of the system by applying the entrepreneurial thrust of the private sector to the marketing of data and services.
- ii. Relieve the Government of the system operating costs by transferring this burden to the users.

Dr. Charyk (COMSAT) :

Establishment of commercially viable space systems have not progressed much beyond the highly successful communications industry entry into space more than a decade ago. The fundamental Government policies necessary for a successful

remote sensing commercialization are not so much undefined as lacking in the primary intent to take this step—postponing an immediate decision through a gradual transition or a program heavily regulated, controlled, and administered by the Federal Government will result in even less favorable circumstances by 1990.

What is needed is a firm resolve to establish a commercial remote sensing entity. This step will result in renewed growth and activity in space sustained by private sector investment and market development.

Dr. Halbouty (Michael T. Halbouty, Inc.):

Government policy (PD-54) did set a stage for a move to an operational system, but in the wrong direction. NOAA was established under PD-54 as the agency responsible for civil remote sensing. NOAA lacked the internal expertise to come up with a good plan for moving to an operational system and they produced draft legislation which would have totally discouraged industrial involvement in civil land remote sensing. PD-54 should be rescinded and NASA should be given total responsibility of working out arrangements with industry. All government civil land remote sensing activities should be managed by NASA. The Landsat MSS system should be designated as operational now and should be immediately upgraded to provide MSS data to users in an operational manner. Industry should be encouraged to participate in the upgrading of the MSS system. By designating the MSS operational, the government will be guaranteeing users a level of performance with respect to MSS data. This is not a guarantee or subsidy to industry. If industry does not come forward with acceptable proposals for participation in the operational aspects of Landsat MSS data distribution, (that is proposals which do not rely on guarantees or subsidies) then the government will have to continue to provide MSS data because it is in the national interest to do so. I believe, however, that if the government designates the Landsat MSS as operational, and thereby identifies the low-risk technological requirements, that the aerospace and value-added remote sensing industries will come forward with good proposals to provide MSS data on an operational basis.

Dr. Simonett (University of California):

The most important positive policy decisions include our position before the United Nations regarding the freedom to "sense" from space, our policy of open and non-discriminatory distribution of data, and the decision to place operational responsibility for the Landsat program within NOAA. The most negative policy decisions have been the NASA funding limitations leading to the present gap in Landsat data continuity, the lack of backup systems, and the NOAA budget limitations that would seem to make it impossible for them to discharge the operational responsibility they now have.

APPENDIX A

LIST OF WITNESSES

July 22, 1981:

James M. Beggs, Administrator, National Aeronautics and Space Administration.

Joseph Wright, Deputy Secretary, The Department of Commerce.

Thomas J. Anderson, National Conference of State Legislatures, accompanied by Paul A. Tessar, Project Director.

Bruce Rado, Program Director, National Governors Association, accompanied by Barbara Dyer, Associate Director of Natural Resources.

Dr. Norman H. MacLeod, President, American Science and Technology Corp., accompanied by Dr. Murray Felsher, Vice President.

July 23, 1981:

Dr. David S. Simonett, Dean of Graduate School, University of California.

Kenneth B. Craib, President, Resources Development Association.

Dr. Michael T. Halbouty, President, Michael T. Halbouty, Inc.

A. J. Rosenberg, Vice President and Manager, General Electric Division.

Dr. Joseph V. Charyk, President and Chief Executive Officer, Comsat General Corp.

APPENDIX B

LIST OF INVITED LETTERS AND PAPERS

Dr. Frederick B. Henderson III, President, The Geosat Committee, Inc.

Dr. Ray A. Williamson, Project Director, Space Program, Office of Technology Assessment.

Dr. Michael T. Halbouty, President, Michael T. Halbouty, Inc.

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